Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JUNE, 1911.

A SCIENTIFIC USE FOR THE STEREOSCOPE.

By A. H. STUART, B.Sc., F.R.A.S.

STUDENTS whose geometrical studies have been confined to the geometry of two dimensions frequently find considerable difficulty when problems in three dimensions are presented to them. Ordinary drawings afford very little help and there remain only two methods by which assistance may be offered, viz., models and stereoscopic drawings. Of these the latter are undoubtedly the easiest to make and the cheapest to produce.

The most elementary knowledge of perspective is all that is required to make stereoscopic drawings of all the usual problems in solid geometry. Figure 1 shows a simple method of drawing a cube in perspective. A figure is drawn for each eye, the

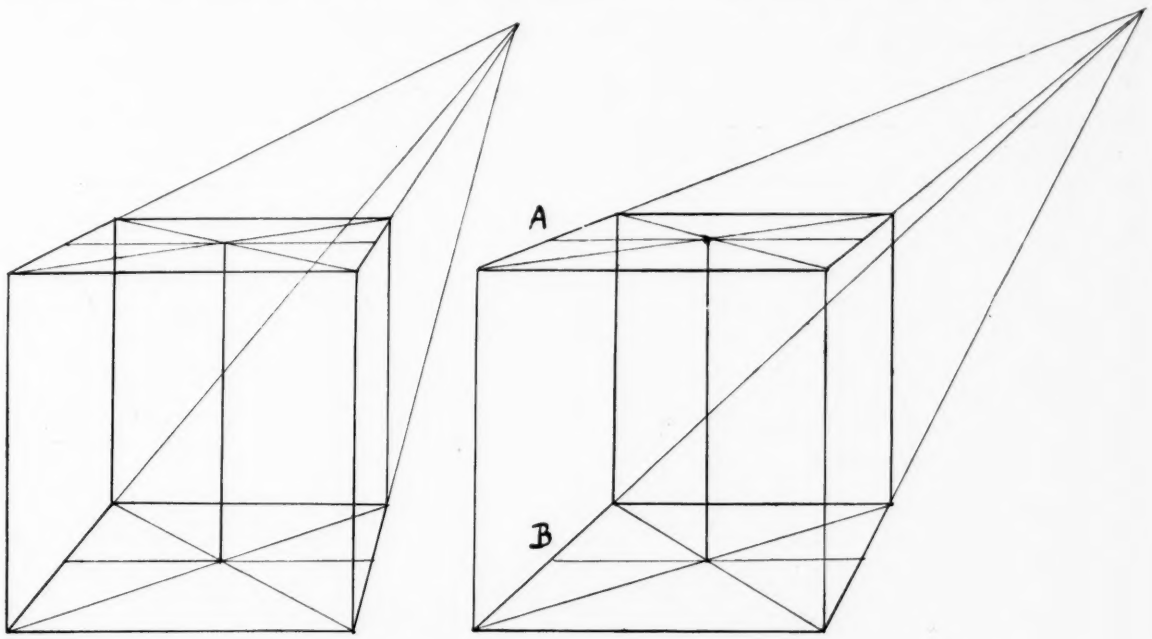


FIGURE 1.

vanishing point of the figure for the right eye being separated from that of the figure for the left eye by a distance about equal to that between the two

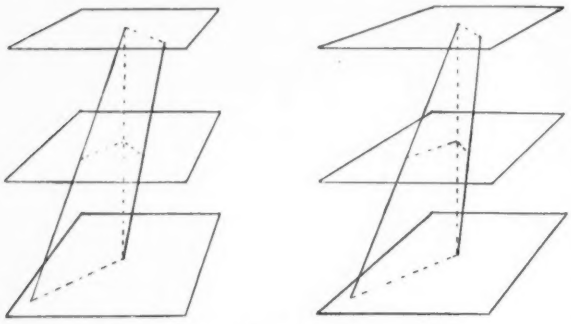


FIGURE 2.

eyes. (In adults this is about 3 inches, while in boys of about fifteen years of age I have found the average to be about 2·5 inches). For all practical purposes the front face of the cube may be represented by a perfect square. The figure also shows the method of obtaining the axis of the cube. It must be remembered that the geometric centre of a face is not necessarily the stereoscopic centre. If the point of intersection of the diagonals is taken, no mistake can be made. Similarly, to obtain the middle point of an edge, draw a line parallel to an edge which is at right angles to the former through the point of intersection of the diagonals. This will cut the edge at the required point. Thus, in Figure 1, A and B are the stereoscopic centres of the edges on which they stand.

I have found it convenient to make the drawing first on a large piece of drawing paper and then prick through the necessary parts on to the paper which is to form the finished slide. This not only has the advantage of not showing the construction lines in the stereoscope, but a large number of figures of different subjects may often be pricked off the same drawing. From the cube a vast number of figures may be derived by the exercise of a very little ingenuity.

Figure 2 represents the figure of a theorem in Euclid, Book XI. By examining this drawing in the stereoscope the figure stands out in relief in a most striking manner, and brings home to the mind of the student the whole meaning of the theorem at once. The construction of these figures by the student is quite an education in itself, in addition to providing him with figures equal to models in every way.

Nor does the mathematical student monopolize the benefits to be derived from the use of the stereoscope. Figure 3 shows how an ill-formed crystal of the octahedral system is derived from the perfect octahedron; a matter which is by no means clear to every student of chemistry. Again, Figure 4 shows the graphical formula of one of the optically active forms of tartaric acid. For obvious reasons, if a figure requires lettering only one of the figures should be lettered.

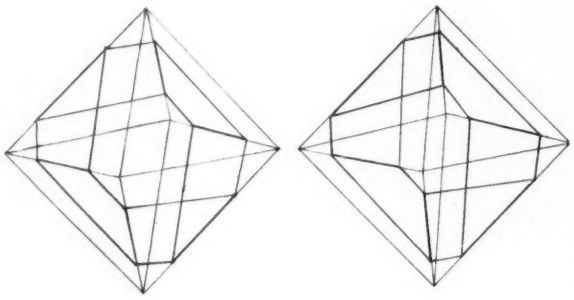


FIGURE 3.

I have found stereoscopic drawings of geometrical solids very useful in demonstrating to physics students the theory of stereoscopic vision. It is perfectly obvious to them that the two drawings of the solid are not alike, and yet, when their images are superimposed by the lenses of the stereoscope, they give the idea of relief as plainly as the solid itself would do.

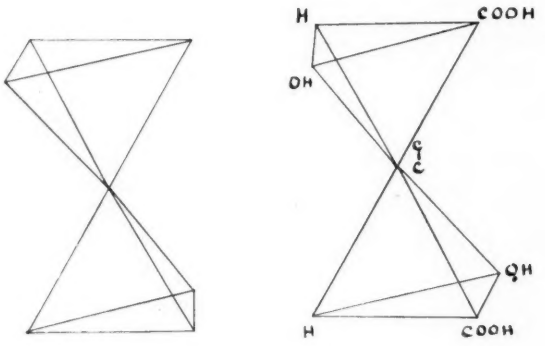
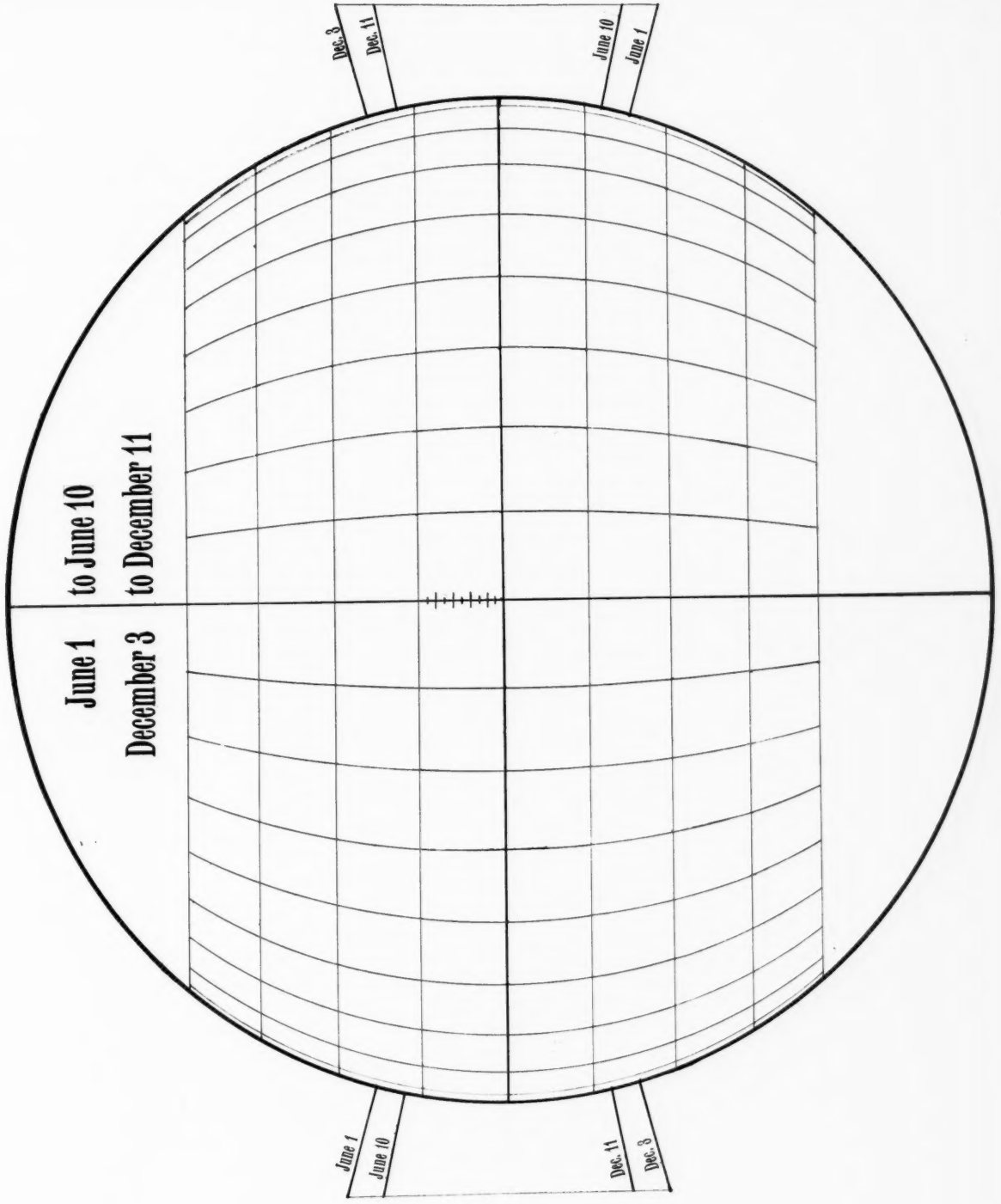


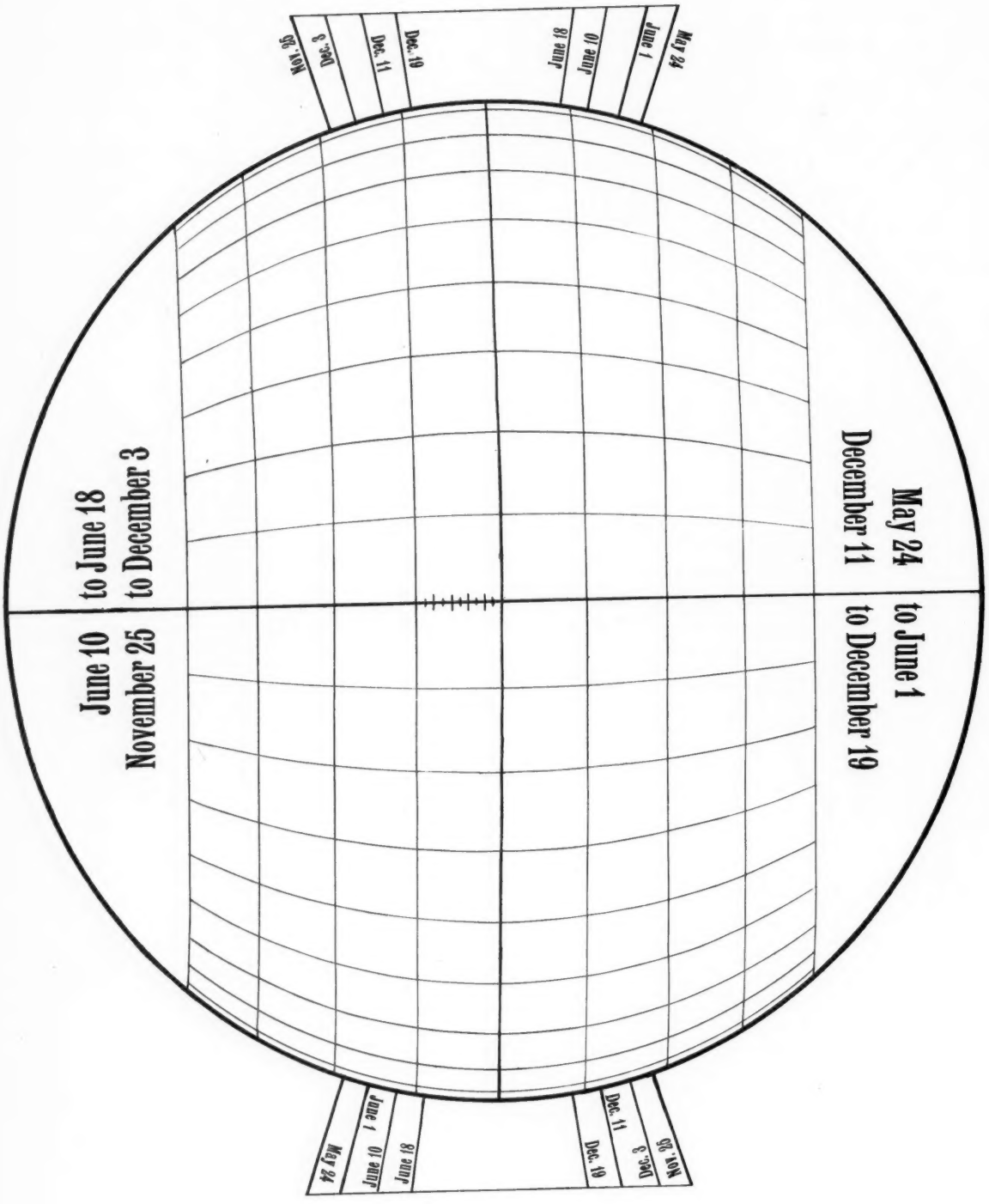
FIGURE 4.

DISCS FOR SOLAR PROJECTION.

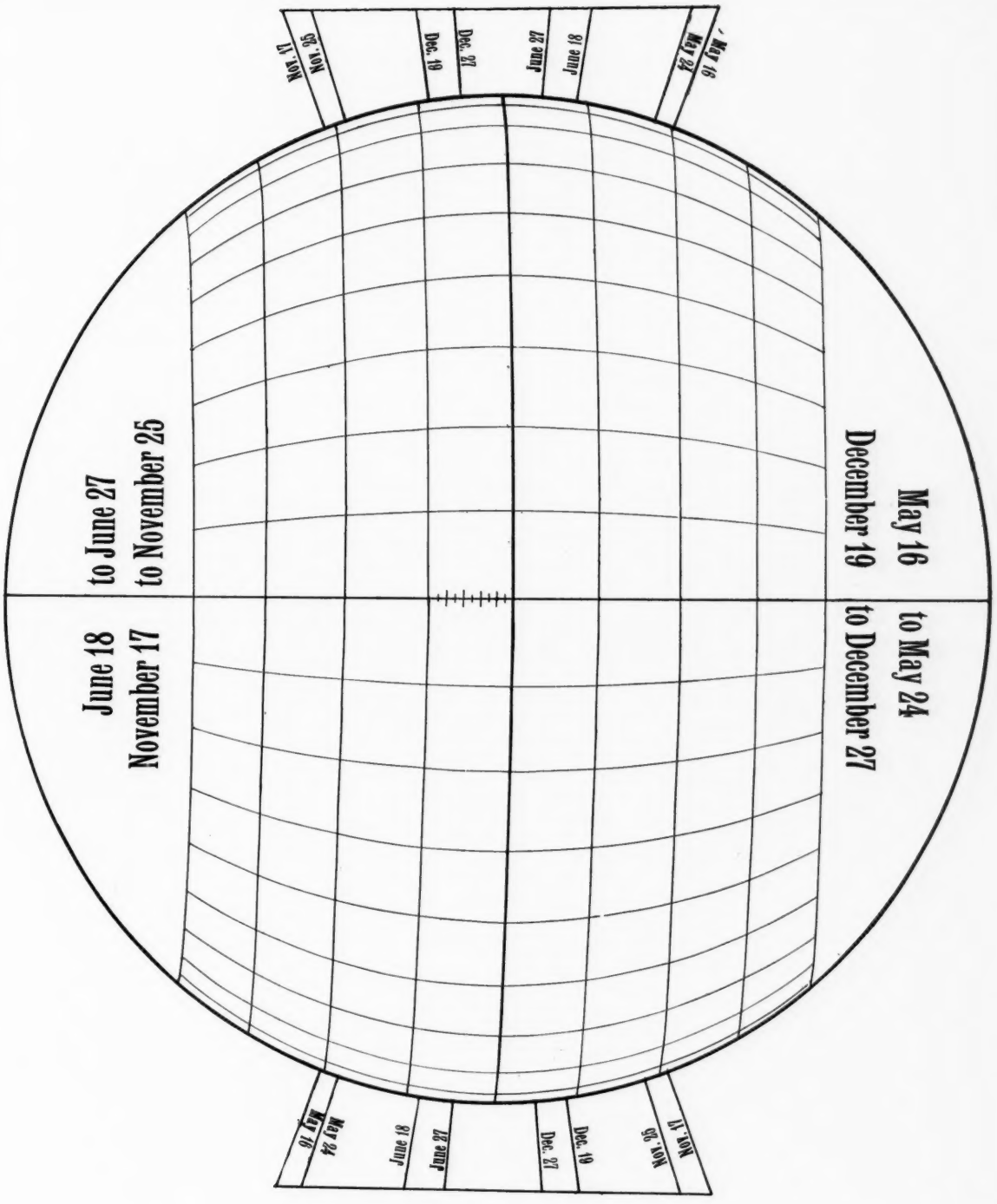
We give here three more of the Maps for Solar Projection belonging to the series described in "KNOWLEDGE" for May, prepared by Mr. John McHarg, which can be used from June 1st to June 27th.



I. Latitude of Centre 0°.



II. Latitude of Centre ± 1°.



III. Latitude of Centre ± 2°.

THE AUSTRIAN RESEARCH VESSEL "ADRIA."

By DR. ALFRED GRADENWITZ.

THE research vessel of the Association for the Advancement of Scientific Investigation in the Adriatic, was built on the D'Este shipyards by the Stabilimento Tecnico of Trieste. Though being of rather modest dimensions, she is most sea-worthy and, on account of her excellent appointments, can be considered a model of her kind. The for covering the rooms located in the hull are only ·70 metres in height, which greatly reduces the side-pressure of the wind. Ample space is provided on the plane deck plates, for installing all kinds of apparatus and doing scientific work. These structures are fitted sideways with quadrangular skylights and protective gratings as well as with

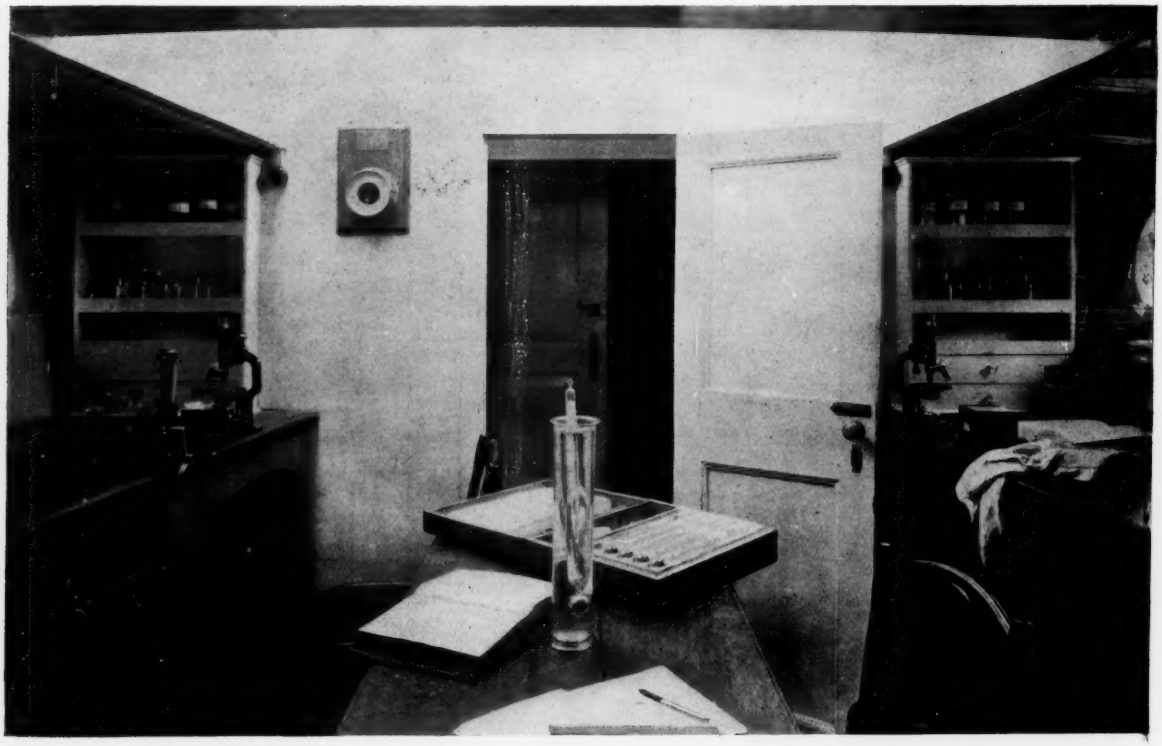


FIGURE 1. The Laboratory on board the "Adria."

"Adria" is mainly intended for the oceanographical and biological investigation of the Adriatic, working in conjunction with the Austrian Zoölogical Station at Trieste.

The chief measurements of the ship are as follows:

Length over all	20·5	metres.
Maximum width	4	,,
Height	2·4	,,
Draught	1·5	,,
Capacity	45	tons.

The hull is made of wood, the frame and keel being of oak, and the inside and outside planking of pitch-pine. A skin of copper plate protects the hull below water against the attack of ship worms.

The various teak wood structures erected on deck hinged hatch lids. The deck is encircled by an iron railing, the lower apertures of which are closed by netting; the upper bars are fitted with pulleys for lowering oceanographic instruments. The front part of the bow (as far as the mast) is set apart for fishing operations and, therefore, is equipped with the most various outfits, comprising a winch for the rapid hoisting of instruments and nets able to raise a weight of several hundredweight from the bottom to the surface of the sea. While being generally operated by electricity, this winch can as well be worked by hand. On its axle are mounted four drums actuated separately and which are designed for plain ropes, cables, piano wires and anchor chains respectively. The rope carrying a net or

heavy instruments travels from the winch over a crane fixed to the mast, thus facilitating the transport of even the heaviest net bags over a shallow trough made from water-tight linen and on which the catch is searched and sorted. Close to the mast there is further a conduit for discharging sea-water so that the whole catch can at any moment be immersed in water.

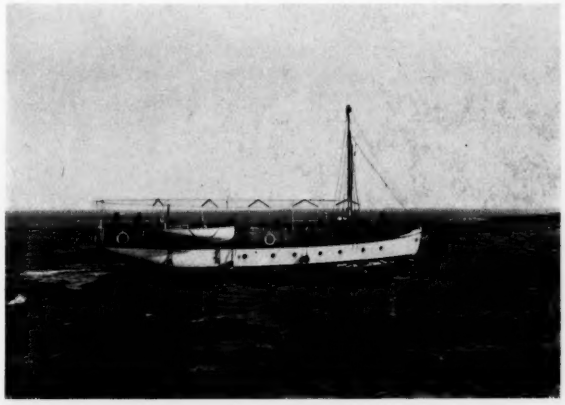


FIGURE 2.
The Research Vessel "Adria" under weigh.

Behind the mast are arranged the structures forming the roofs of the laboratory located below deck, the combined saloon and bedroom, and finally, the engine room The rudder, which is actuated with extreme ease through a worm engaging directly with its shaft, is located astern, with a view to utilising as much space as possible for fishing operations, as well as on account of the greater simplicity and safety.

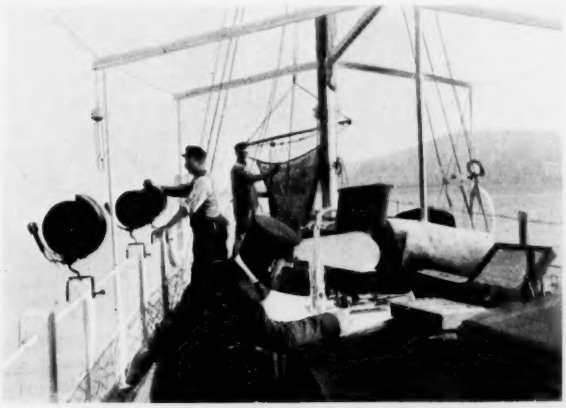


FIGURE 3.
An Oceanographical Specialist at work.

Of special importance are the sea-water tanks for receiving any marine animals and plants caught by the net. As these manifold organisms should be taken home alive, the "Adria" is equipped with what could fitly be called a complete aquarium, comprising three wooden cases lined inside with sheet metal and which contain three to four removable sheet metal aquarium tanks serving at the same time for the transport of marine animals from the ship to the shore. The wooden cases which, when closed, can be used as benches, are provided with conduits for sea water and compressed air, enabling any animals and algae to be kept in circulating or ventilated water. In the hind part of the vessel is installed a large tank likewise containing circulating sea water and compressed air and which takes up nearly the whole width of the ship. This is intended for receiving big fish and marine animals.

The supply of sea-water to the aquarium tanks is effected during the time the ship engine is at work, that is, throughout the course of the vessel, by a pump coupled to the propeller shaft, while an electrically-operated centrifugal pump is resorted to during intervals in its operation. The compressed air is generated by a compressor connected to the ship motor which allows air to be compressed in cylindrical iron vessels to four atmospheres, reduced by a throttle valve to one-twentieth of an atmosphere. The compressed air also serves to actuate the whistle of the ship.

The compass, a fresh-water tank and an ice tank are likewise located astern.

On each side of the vessel is suspended from a crane a launch four metres in length. These launches, one of which is equipped with a gasoline motor of two-and-a-half horse power, are intended for landing at and exploring such parts of the coast as are not accessible to the "Adria."

As regards next the arrangements provided below deck, the copper tank containing the fuel (gasoline, petroleum or alcohol) is located in the very front of the fore-ship, being separated by a fire-proof metal partition from the bedroom of the crew. This tank has a capacity of about nine hundred kilogrammes, which enables the vessel continually to sail about fifty hours, covering a distance of about four hundred and fifty knots. As the motor is mostly stopped by night, a new fill of fuel generally is required only every five days.

The bedroom of the crew also contains anchor chains, tows, tent covers, nets, and flags. A special room is provided for photographic work.

FIGURE 4.
The Plankton Nets being hoisted astern.

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The Laboratory (see Figure 1), like the adjoining saloon, is dominated by a roof structure and derives its light partly from the side-windows of the latter and partly from four circular hatchways in the ship's walls. On its longitudinal sides are arranged lockers ·90 metre in height for stowing away instruments, on the top of which ample room is provided for performing all sorts of operations and installing scientific apparatus. The laboratory further comprises a compressed-air conduit with six discharges, allowing small aquarium tanks to be thoroughly aërated. Two additional berths can be made up on the instrument lockers in cases of emergency. As the ship engine works with remarkable smoothness, microscopes of modest magnifying power can very well be used in a quiet sea, which is the more advantageous as the plankton of the sea should be examined while still alive, at least for its main characteristics. The Laboratory is, of course, equipped with all sorts of oceanographic and other instruments.

In the middle of the ship, viz., in the part taken up on steamers by the engine and boiler, is located a spacious, well-aërated and lighted saloon, which serves as dining as well as bedroom. Alongside its longitudinal walls are installed four berths with chests of drawers and on its transversal walls four wardrobes, one of which has been converted into a pantry, containing an ample supply of crockery.

The engine plant is located in the hind part of the vessel. The engine is a seventy-five horse-power motor, constructed by the Wolverine Works, at Grand Rapids, Michigan, imparting to the ship a speed of nine knots, which, thanks to the excellent design of its carburettor, can be operated at will with gasoline, petroleum, or alcohol. This motor is of a very substantial construction and remarkably simple manipulation and superintendence, being started merely by a pressure on the lever of the electrical ignition, in order afterwards to go on working quite automatically, needing inspection only from time to time. This engine has repeatedly stood severe tests in a rough sea with excellent results. In order to afford greater stability in a gale and heavy seas, the vessel has been equipped with a triangular sail and a jib.

This engine is coupled to the air compressor supplying air for aërating the aquarium tanks and operating the ship's whistle. In the same part of the vessel is located the electric plant which comprises a two horse-power gasoline motor coupled to a dynamo, generating electric current at sixty-five volts tension for operating the winches and lighting the vessel. It is supplemented by an accumulator battery of thirty-six cells, resorted to in cases of emergency and when the dynamo is stopped. Scientific work can thus be continued even by night, allowing, *e.g.*, the air bubbles from bottles immersed in the sea to be watched with a view to ascertaining the course of water currents. The installation of a search-light will likewise be of much importance for biological and oceanographic purposes. Finally, there is a possibility of operating directly from the dynamo or accumulator battery, a sea-water pump for keeping up the water circulation in the aquarium tanks.

Adjoining the engine room is the ship's kitchen which, in spite of its diminutive dimensions, perfectly suffices for its task. It is equipped with an economiser stove for coal firing and all necessary kitchen utensils.

Apart from its use as a research vessel the "Adria" is also to serve for instructional purposes, in connection with periodical journeys of scientific discovery for the benefit of undergraduate students.

SCIENCE AT THE CORONATION EXHIBITION.

FOR a third time a science section has been arranged at the Shepherd's Bush Exhibition, and this year the Committee, of which Sir Alexander Pedler, F.R.S., is Chairman, has brought together a number of very interesting exhibits. We hope to deal with some of these in detail, but at the moment we may point out that a feature of the Astronomical division is a series of transparencies, while there are collections of sundials and astrolabes, as well as some remarkable models sent by Greenwich Observatory. The Meteorological Office illustrates its useful work and there are some instruments on view. Anthropology is represented by measuring instruments, old and new; by a series of casts of the oldest known skulls; and by Dr. Gray's Perseveration apparatus, described by him in "KNOWLEDGE" for December, 1910. It is kept in a small bureau in the right hand corner (going from Uxbridge Road), of the first building devoted to science, and visitors may be tested upon application. Fifty years' work of the Geologists' Association is represented by collections made upon the well-known excursions of the society, and there is a good series of fossils showing changes in structure of the teeth of *Ceratodus*. The fossil eggs of fishes are noteworthy, and the specimens of the spines of sea urchins which, though alike externally, show internal structure which is characteristic of the various species.

The apparatus employed for investigations on the rusting of iron is a special exhibit in the Chemical division in which also coloured compounds, new drugs, and the making of Vanadium steel are illustrated. Physics is necessarily chiefly represented by apparatus. The Biological exhibits are not extensive but call for special attention. The London School of Tropical Medicine sends a detailed exhibit including a prehistoric skull showing that trepanning was practised long ago. University College, Bristol, exhibits some excellent models showing electric installations in connection with the growing of crops in field and in greenhouse. The Selborne Society makes a display of the English nesting boxes recently introduced with much success. The Agricultural exhibits illustrate the work of the Board of Agriculture in the way of distributing maps, of fisheries, and the study of plant diseases as well as of forestry. The Earthquake-recording instruments shown have been of practical value in connection with railway work and the balancing of engines. The Royal Geographical Society sends facsimiles of the maps of celebrated explorers and one or two relics. Oceanography occupies itself with submarine cables, and in this division is shown a number of photomicrographs of minute forms of marine life, such as were found at very great depths.

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CONCERNING DIMENSIONS GENERALLY, AND THE EFFECTS OF THE FOURTH DIMENSION IN PARTICULAR.

By A. L. ANNISON.

THE word dimension is the general term used to indicate extension in space, whilst space itself is nothing more than the abstract idea of infinite extension in all known directions.

There are said to be three dimensions, namely, those of length, breadth and thickness, and all our conceptions of shape and size are formed relatively to one or more of these three, which seem quite adequate for the expression of our ideas. The existence of others must, therefore, seem extremely problematical, and if at times a guess is hazarded as to the fourth dimension, its nature is assumed to be quite different from that of the other three; so much so, indeed, that in some instances it is held to consist of time itself.

Now it is one purpose of this article to show that from certain facts which we shall proceed to examine, the existence of an infinite number of dimensions may justifiably be deduced. It will be shown that these dimensions are of the same nature as the three with which we are familiar, and that our ignorance of their existence is due to some personal limitation whereby we are unable to form any mental image of the shape and size of a body, beyond that small portion of it which is bounded by a surface extending only in the first three dimensions, the others, therefore, seeming to be nothing more than purely abstract ideas derived from mathematical expressions.

Notwithstanding this, however, we shall also be able to show that some of the effects of the fourth dimension are of such a nature as to be appreciable in spite of our limitations; and the latter part of this article relates to the nature of these effects and under what conditions they can be produced.

The basis of our argument depends on the relation between algebraical equations of two and three variables and geometrical figures of two and three dimensions. It is known, for instance, that the locus of a point moving according to the equation $x^2+y^2=r^2$, is the circumference of a circle, or in other words the equation is the "law of the circle": and similarly $x^2+y^2+z^2=r^2$ is that of the sphere; but there are an infinite number of equations of this type, each containing one more variable than the preceding one; and arguing by analogy from the first two, the next one $x^2+y^2+z^2+u^2=r^2$ is the law of a four-dimensioned figure; $x^2+y^2+z^2+u^2+v^2=r^2$, of a five-dimensioned one, and generally x^2+y^2+ – – (η terms in all) $=r^2$ of an η dimensioned one, where η may be any number between 2 and ∞.

The fact that we are unable to form any mental image of such figures cannot be ascribed to the equations themselves, which obviously contain no reason either why they should or should not be capable of graphical representation. *Prima facie*, if some equations can be so treated, the remainder should equally admit of such treatment, and our inability to accomplish this must obviously be due to the absence of any mental picture that will satisfy the requirements of the equations.

Now the pictures that we can conceive consist of nothing more than the figures formed by enclosing a portion of space, either by a line or lines (plane figures) or by a surface or surfaces (solid figures); the line and the surface are the materials with which we construct these figures. We cannot, however, construct a four-dimensioned figure of any kind, although we have the necessary material, namely, what for want of a better name must be designated the volume.

The inability of our imagination in this respect must be due to some limitation in our powers of perception, for it is from the impressions of external objects, as seen by the eyes, that we form our mental images of figures, regular or irregular.

Now it will be shown that our eyes cannot appreciate any figure with more than three dimensions. It might be argued from this, that it does not follow that there are such figures to be seen, but from an examination which we shall make of the undoubted fact that all visible bodies by which we are surrounded are at least three-dimensioned, the existence of these more complex figures can be inferred.

By the term "body" employed above, is meant something that has an independent existence and is, therefore, an object as distinguished from an attribute.

All bodies, as we shall see, are defined by their apparent size and shape and are, therefore, figures of some kind, regular or irregular; but on the other hand all figures are not bodies, for every two-dimensioned figure is only found as a bounding surface of a three-dimensioned one, and by itself is quite as abstract as colour, taste, and all other attributes.

So far as we know, however, the three-dimensioned bodies appear to be self-contained and independent of any higher dimensioned body; they do not seem to exist merely as the sections of four-dimensioned figures.

It will be shown that this can be accounted for by the limitation of our powers of observation, and

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that there is no cause why four and other dimensioned figures should not exist; from this it follows that the only figures which are not the sections of higher dimensioned ones must be those possessing an infinite number of dimensions; in other words, these last mentioned figures are the only ones that can have an individual existence.

The first point for us to determine is the possession by every visible body of at least three dimensions; we shall then proceed to show that they must be inferred to possess an infinite number of such dimensions; and finally to examine the effects produced by certain four-dimensioned figures, firstly when moving in the direction of the axis of the fourth dimension and secondly when expanding and contracting in the three-dimensions with which we are familiar.

Now all visible bodies must necessarily have dimension of some kind.

The impressions of things external to our mind are received and transmitted to it by means of the senses and their organs; and we must consequently remain utterly ignorant of anything that does not appeal to at least one of our senses.

We find that all sense impressions conveyed to us have their origin in objects that possess extension in space. Colour, scent, light, sound, taste, heat and cold, all are invariably found to proceed from such a body; and conversely there is no visible body that has not extension in space, a possession which is indeed its primary attribute, all others such as colour, taste, and so forth being of secondary importance.

When we proceed to consider those things that have dimension, we find that some only of them have an independent existence and therefore comply with our definition of a body. Others, which are figures only, and nothing more, do not exist apart but are only attributes of a body. Thus we find that a solid such as a cube is an actual object, but a surface such as the square merely forms part of the solid; we do not find one existing alone, absolutely dispossessed of thickness.

The straight line is nothing more than part of the boundary of a plane figure; and so far is it from possessing an independent objective existence that it is even unimaginable; for geometrical purposes we have to allow it some degree of thickness, although we thereby convert it into a plane surface.

The solid, then, is a body, because in addition to its length and breadth it possesses thickness; whilst lines, having merely one dimension, can only serve for the construction of a plane figure, and the plane figure by itself, having only two dimensions, is no more an object than the line; it is an abstraction that serves as an attribute of a three-dimensioned body.

Now all visible bodies are found to have three dimensions; there is no body, either artificial or natural, that has not length, breadth and thickness. Our next step is to enquire why this is so. On the one hand it may be because there are no one or two dimensioned bodies; and, on the other, because we ourselves, on account of some inherent limitations in our power of sight, are unable to perceive them. This last hypothesis, however, is obviously untrue, for not only do we see that part of a body which possesses only length and breadth, that is to say its surface, but that is all we can see.

It is, therefore, obvious that we could detect the presence of any plane surface, such as a square, if such a figure ever had an independent existence.

Let us imagine a square of this nature to come within the sphere of our observation. What characteristic impression would it produce on us?

Well, suppose that we first of all observed it when looking in a direction at right angles to the plane in which it lies; it would then appear as a square. Now let us move as though we were about to pass by its upstanding edge on one side, in order to attain a position at its rear. With our eyes directed on it the square would apparently diminish in width, but not in height, becoming narrower and narrower, until nothing but a small strip remained; and even this would finally disappear when one reached the edge of the figure; the square would be completely invisible, since it has no thickness. Then, as we passed beyond its edge and towards the rear, the surface would reappear, and increase in apparent width, until it regained its full size and shape.

Now such a phenomenon as this has never been seen, and it therefore follows that there are no bodies with only two dimensions; and further that there cannot be any with simply one, for if there were, a two-dimensioned body could be constructed therefrom.

In the course of the foregoing arguments it was remarked that we could only perceive the surface of a body; and that, therefore, if we looked at a plane surface, we only observed its length and breadth, the thickness remaining unperceived and undetermined. Our next point of inquiry will endeavour to explain why we only see the plane, and how it is that we can ascertain the existence of the third dimension.

The eye is, of course, the organ of sight; it comprises a lens and a screen called the retina. This screen consists of a surface, and is analogous to the sheet on which magic lantern pictures are displayed, the eye lens being equivalent to the compound lens of the lantern.

Now, it is impossible to produce anything but a flat picture on the lantern sheet; the image of a globe, for instance, cannot be projected so as to possess length, breadth, and thickness; the length and breadth can be displayed, because the screen itself is a plane surface, but the thickness can only be simulated by a skilful distribution of light and shade.

Similarly the image impressed on the retina is essentially two-dimensioned; and for this reason we are frequently led to mistake a round body for a flat one; the moon, for instance, always appears to be flat.

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The image produced by the eye being invariably a plane figure, we should be unable to determine whether a body were two or three dimensioned if neither we nor the body surveyed could move relatively to one another.

As it is we are enabled to survey a sphere, a cube, a tree, a house, or any other object from innumerable points of view within our three-dimensioned space and thus to inspect its surface or surfaces and satisfy ourselves that it is indeed a solid; our opinion is formed from the multitudinous images impressed on the retina of the eye as we move about from point to point or avail ourselves of the motion of the body which serves to display its various parts before ourselves, the observers.

Now just as we mistake solid figures for plane ones, so in a like manner when we survey a four, five or infinitely dimensioned figure we should imagine it to be three-dimensioned; for it would completely satisfy the investigations we could make, by looking at it from all possible points of view within our three-dimensioned space; of course, its shape as regards the fourth and higher dimensions would remain inscrutable to us, so that we could not possibly foretell their existence or non-existence; but they might be there all the same, for we could prove nothing to the contrary.

Now proceeding briefly to summarise the conclusions attained we may state that:—

(1) Algebraical equations of one, two and three variables can be graphically represented; and certain of these equations with two or three variables are the laws of certain plane and solid figures. In particular $x^2+y^2=r^2$ represents a circle and $x^2+y^2+z^2=r^2$ represents a sphere. If in the last-mentioned equation we put $z=o$, we obtain the first equation which can be shown graphically to represent a section of the sphere.

There are an infinite number of equations in this series, and if we take the next higher one $x^2+y^2+z^2+u^2=r^2$ and put $u=o$, we obtain the equation of the sphere; in other words the sphere is a section of this four-dimensioned figure; we do not, however, mean to imply that it cannot also be the section of other four-dimensioned figures, since obviously it can be, precisely in the same way that a circle might be the section of a cylinder, cone, or other solid.

The four-dimensioned figure is the section of a five-dimensioned one, and this progression is continued to infinity, the infinitely dimensioned figure being the only one that is not a section of a higher dimensioned figure. In spite, however, of the necessary existence of these complex figures we are not acquainted with any of them from the four-dimensioned one upwards.

(2) All our ideas of figures cannot be more than three-dimensioned because of the limitations in our powers of observation.

(3) There are no one or two-dimensioned bodies; all bodies appear to be three-dimensioned, and two-dimensioned figures are only found in reality as sections of these bodies. This is in accordance with the algebraical equations from which it can be deduced that the straight line is the section of a circle or other two-dimensioned figure, and the latter a section of a three-dimensioned figure such as the sphere.

(4) That the sphere is apparently not a section of a four-dimensioned figure, but appears to belong to that highest type of figure which extends in all possible dimensions (supposed to be three in number), is a fact that is not in accordance with what we should expect from the algebraical equations; but it can be brought into agreement therewith by allowing for our undoubted inability to appreciate more than three dimensions, together with the certainty that any four or higher dimensioned figures would appear three-dimensioned to ourselves.

(5) Paragraphs 3 and 4 explain why all visible bodies appear to possess three dimensions and neither more nor less, and since there are no one or two dimensioned bodies, there is no justifiable reason why there should be any three, four, or finitely dimensioned ones; on the other hand, all bodies must be infinitely dimensioned, although we, by reason of our personal limitations cannot perceive more than three of these dimensions.

(6) Obviously space itself, the ether and other bodies, must also be infinitely dimensioned.

Now from any body such as one whose algebraical equation is $x^2+y^2+\ldots$ (∞ terms in all)$=r^2$, we can take a section, obtaining thus a figure whose equation is $x^2+y^2+\ldots$ ($\infty-1$ terms in all)$=r^2$, and then a section of this, and so on until we obtain the four-dimensioned figure $x^2+y^2+z^2+u^2=r^2$, the sphere $x^2+y^2+z^2=r^2$ and the circle $x^2+y^2=r^2$. Conversely, starting with the circle, we can say it is the section of a sphere, a cone, a cylinder, or some other solid figure; and similarly the sphere is the section of a four-dimensioned figure which may belong to the spherical type, the conical type, the cylindrical type, or some other.

Our purpose now is to take the sphere, cone, and cylinder and show how they would appear if we were only two-dimensioned, and how we could distinguish one from the other; and then, arguing by analogy to show how the four-dimensioned figures of the spherical, conical, and cylindrical types would similarly appear to us with our three-dimensioned faculties, and how the effects produced by them would be characteristic and distinguishable from one another,

The simplest way to proceed is to hypothecate the existence of a two-dimensioned being, one who can only perceive length and breadth and is absolutely ignorant of the existence of thickness; his observations must be confined to what takes place on a plane surface which, consisting of infinite length and breadth, will be to him what space is to us.

The only figures of whose existence he can possibly be aware must be two-dimensioned ones,

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and these only if they lie in his plane of observation. Such figures would be presented when a solid was intersected by the plane surface. Now we can imagine a solid to move downwards towards the surface from above and to pass completely through it. Before and after the passage of the solid, no part of it would be seen by the being, but during the event, he would observe a series of sections, each consisting of a plane figure.

Now these sections, of course, would be definitely correlated to one another, since one and all belong to the same body, and from their change or constancy in size and shape, it would be possible for the being to determine the nature of the solid figure. Thus from the fact that he saw a circle of unvarying diameter, he could hypothecate the existence of a cylinder; and similarly, if the circle were one that appeared to increase or decrease in diameter, it could be ascribed to the existence of a right circular cone, sphere, or some other solid figure whose cross section was a circle.

Furthermore, the particular kind of solid could be deduced, for they would each produce a different and characteristic change in the size of the circle. A sphere, for instance, would produce a circle at first no larger than a point, but which would increase gradually until it became a great circle of the sphere and then decrease again to a point. A right circular cone, assuming it to approach apex first, and parallel with the axis of the third dimension, would also first produce a circle no larger than a point; this would also gradually grow, but it would not subsequently decrease like that produced by the sphere. Furthermore, provided that both cone and sphere moved downwards with uniform velocity, there would also be this difference—that any point on the circular section of the cone would move radially outwards with a uniform velocity, whilst any point on the similar section of the sphere would move outwards with variable velocity; and its acceleration would be just as characteristic of the sphere as the uniform velocity was of the cone. Any other figure would produce a characteristic acceleration.

Now just as the sphere and cone moving downwards along the axis of the third dimension presented the phenomenon of a plane figure (the circle) growing equally in the two dimensions of the plane, so would the spherical figure of the fourth dimension (equation $x^2+y^2+z^2+u^2=r^2$), and the cone-like figure of the same degree, each moving downwards along the axis of the fourth dimension with a uniform velocity, present to us the phenomenon of a solid figure (the sphere) growing equally in the three dimensions of space; in the first instance with characteristic acceleration, and in the second with uniform velocity; and just as it is possible to account for any imaginable change in the size and shape of a plane figure by the hypothesis that it forms part of a solid figure moving downwards along the axis of the third dimension, so similarly is it possible to explain any increase or decrease in the length, breadth and thickness of a solid figure by the hypothesis that it forms part of a four-dimensioned figure moving downwards along the axis of the fourth dimension.

It is likewise possible to explain the propagation of ether and other vibrations, originating from a point, in the same way; for we know that such vibrations, starting from the point, advance at a uniform rate in all directions, so that the wave front of each vibration consists of a sphere constantly growing outwards at a uniform velocity, the precise phenomena that would be produced by a downward movement along the fourth dimension of some four-dimensioned cone-like figure.

There is this objection, however, to such a theory, that if ether is infinitely dimensioned, there is no reason why the vibrations should not extend equally in all of them, so that the shape of each wave front would be represented by the formula $x^2+y^2+\ldots$ (∞ terms in all)$=r^2$, and it is impossible to presuppose this figure to be the section of any other figure or for it to be caused by motion along a dimension not included in the equation, for all the dimensions are included therein.

There is, however, another point of view from which to regard the propagation of these vibrations.

It is known that before the discharge of an electric spark, the ether in the neighbourhood is in a state of tension; it might be regarded as being attracted towards the point where the electrical charge is collected.

Now suppose for the moment that we regard the ether as only three-dimensioned, and ourselves to be only capable of appreciating two dimensions; and let the charged point lie in the plane of our observation. The ether will be attracted to the point from all directions, and we may imagine the space about the point divided up into an infinite number of contiguous cones of ether, all with their apices at the charged point; in the normal state of affairs, with no electrical charge in the neighbourhood, these cones would become cylindrical tubes, and the conical shape is therefore always an unstable one, tending to revert to the cylindrical form as soon as the point is discharged. It is obvious that in undergoing this change of form on the discharge taking place, all we should appreciate would be an ether disturbance travelling outwards from the point in the form of an ever-increasing circle; for we could only observe the lateral expansion of the cone whose axis was perpendicular to our plane of observation; all the other cones in their expansion would immediately extend above or below our plane, and thus become unobservable.

Now similarly, since we observe an electrical disturbance to travel outwards in an ever-growing sphere, we may imagine the ether in the neighbourhood of the charged point to be composed of a series of four-dimensioned, cone-like figures; or assuming that the disturbance travels outwards in as many dimensions as possible, to be composed of infinitely dimensioned cone-like figures, each of which has for cross section a figure whose equation is $x^2+y^2+\ldots$ ($\infty-1$ terms in all)$=r^2$.

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AN INEXPENSIVE APPARATUS FOR THE SYSTEMATIC SEPARATION OF SEDIMENTS BY MEANS OF HEAVY SOLUTIONS.

By CHARLES R. MAPP, F.R.M.S.

HEAVY solutions, such as those of Klein, Sonstadt, Rohrbach, or Braun, offer a ready and fairly satisfactory means of separating sediments, sands, and comminuted rocks into groups varying in specific gravity, and thus materially assist the laboratory examination of such material for the identification and estimation of the component minerals either qualitatively or quantitatively. In using them, however, numerous small difficulties present themselves, and the process becomes both lengthy and tedious unless carried out in definite steps, which, by repeated use, become quite mechanical.

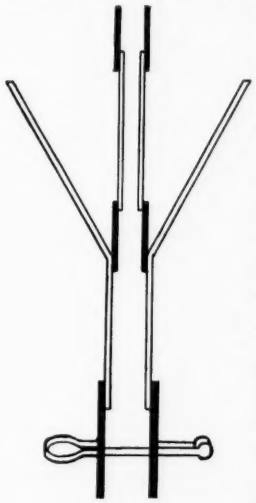

FIGURE 1.

Having recently had occasion to so examine numerous specimens of Liassic and Keuper rocks, a simple piece of apparatus which could be made easily and at small cost became desirable. Unforeseen defects occurred frequently, which rendered modifications necessary, but the apparatus described below will be found to work satisfactorily for ordinary purposes. It is a modified form of one described by Dr. J. W. Evans (see *Geol. Mag.* 1891, page 67).

It can be made readily with a glass funnel, a spring clip, a thistle funnel, and glass and rubber tubing. Figure 1 represents a section of the complete apparatus. The funnel is cut off about half an inch below the shoulder, and to the cut end is attached a piece of rubber tubing about one inch long. A spring clip like those employed with burettes, either of Mohr's or Hofmann's pattern, is fixed on this indiarubber tubing. The remaining portion consists of a piece of glass tubing, having the same, or nearly the same, bore as the stem of the funnel, with a short length of rubber tubing at each end. The construction is better seen in Figures 2 and 3. The lower end is provided with indiarubber tubing of such a size that it forms a fairly tight fit when pressed down into the funnel stem, while it is of smaller bore than the glass tubing. Since it has to be stretched to fit on to the glass tube, the portion which projects over the glass, and which should be about half an inch long will form a truncated cone, which will securely close the entrance to the stem of the funnel when pressed down with a rotating motion. At the upper extremity there are two separate pieces of glass, which are used at different stages in the manipulation. In the diagram (Figure 2), X is a piece of glass rod, or of glass tubing closed at each end, which can readily be inserted into the short length of rubber tubing to render that end air-tight. In Figure 3, Y is the head of a thistle funnel, which can be similarly inserted.

Now as to the method employed in fractionating the sediments. The funnel can be fixed on the ring of a retort stand or other convenient support. The heavy solution of the particular specific gravity to be used is now poured in carefully, to within a reasonable distance of the top of the funnel. It will be found to be a good plan to place the bottle under the funnel, and after cautiously opening the clip slightly, to let a small quantity of the liquid flow out, both to remove any air bubbles and to ensure that the whole surface of the rubber tubing is wetted.

The sediment or grains of matter to be separated, which should previously have been washed and dried, or treated in any way chemically, are now poured on to the surface of the liquid. The stopper with the part X in the upper end, may next be used to stir the sediment thoroughly into the liquid. The object in having the upper end closed by X is to keep the stopper full of air, and so prevent any of the liquid entering it by capillary attraction, in which case grains are invariably taken up by the liquid, interfering with the success of the separation at a later stage. The stopper is now laid aside, and the liquid is allowed to settle for several hours. If the heavy liquid used is hygroscopic, the

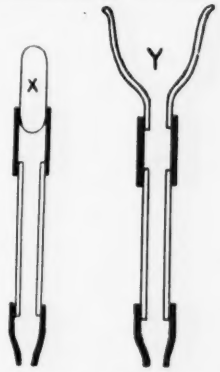

FIGURE 2. FIGURE 3.

funnel should be covered by a piece of clean paper. The heavy mineral grains should now collect in the portion between the clip and the neck of the funnel. When no further movement can be detected the stopper is plunged below the surface of the liquid, and moved carefully to and fro several times, to rid it of any grains which have been carried down on its lower extremity, and then inserted in the neck of the funnel with a rotary motion which fixes it firmly in the neck. The plug X is removed and the thistle funnel head Y inserted in its place. A second funnel with a folded filter paper in it is placed in the neck of the solution bottle which is placed beneath the apparatus.

The clip is next opened quickly, and the liquid from the portion below the stopper flows out carrying with it the heavy grains. More fresh liquid is now poured into the thistle funnel which flows down and washes any adhering grains out. The clip is then closed again. The filtered liquid flows back into the bottle and can be used again, while the grains are retained on the filter paper (funnel A) Figure 4.

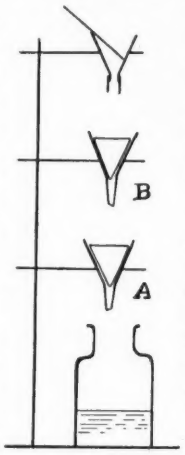

FIGURE 4.

The stopper is now removed, and put aside to be washed. A third funnel with filter paper is also placed in the neck of the bottle which is again placed below the apparatus. The clip is opened again and all the liquid flows out carrying with it the lighter portion of the grains. An additional amount of liquid poured in the separating funnel will also flow out and carry with it any remaining grains which have adhered to the funnel or tubes. The liquid will filter into the bottle, while the grains will be retained on this second paper (funnel B). All that now remains to be done, preparatory to mounting for examination, is to wash the grains thoroughly. The liquids used being fairly expensive, it is also desirable to perform this washing economically. The following suggestions are offered with a view to collecting the washings from the various funnels, papers, and grains, for concentration. If all the washings are so retained in a stock bottle and periodically treated suitably, great saving is effected, since the resulting concentrated solution may be used for fresh separations.

There will thus be three funnels to be washed :— (1) the separating funnel; (2) funnel A with the heavy grains; (3) funnel B with the lighter grains.

It is suggested that a retort stand with three narrow rings, or any stand with three supports capable of holding the three funnels in such a position that they are vertically over each other, be used. Figure 4 gives a diagrammatical representation of the arrangement.

In the top ring is the separating funnel, with the spring clip removed and the stopper resting in it. In the middle ring is funnel B which has the filter paper holding the lighter grains. The lowest ring supports funnel A which has the heavy grains on the filter paper. It is advocated that these funnels be arranged in this order for the following reason. Any grains, which will belong to the lighter portion of the separation, which have not been washed down from the separating funnel, will fall down to funnel B with the washing water, and so join the proper set of grains. If funnel A were placed in the middle there would be a danger of these grains getting into the wrong set.

A fine spray of distilled water is directed on to the surface of the top funnel from a wash bottle, and this water, after cleaning that funnel, passes down through B and A, finally entering the stock bottle of washings placed underneath. Five or six such washings should suffice to clean the grains and apparatus.

The filter papers bearing the grains may next be dried in a steam oven, or in any dry place free from dust.

The chief defect in this apparatus, which is common to all similar ones, is that the separation is not entirely reliable, owing to surface tension and similar small attractions which are inevitably present in the liquid. Figure 5 shows the chief regions where these operate. In the shaded portions the grains are under slight attractions, due to the above-mentioned causes; consequently heavy grains which get into these marginal parts, may not sink properly.

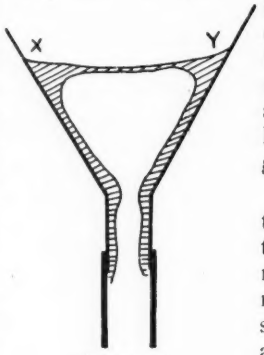

FIGURE 5.

At X and Y particularly, there is a tendency for the grains to climb up the sides of the funnel, above the mean level of the liquid, where the meniscus touches the sloping glass sides. Great care and perseverance are necessary to overcome this and other inevitable difficulties.

By keeping three sets of this apparatus in use on one stand for liquids of different densities, the grains may be sorted into four sets.

Using liquids of Specific Gravity, 2·7, 2·9, and 3·1, the following sets may be obtained :—

(1) Specific Gravity less than 2·7.
(2) Specific Gravity between 2·7 and 2·9.
(3) Specific Gravity between 2·9 and 3·1.
(4) Specific Gravity greater than 3·1.

By increasing the number of liquids, the grains may further be differentiated into more restricted sets.

THE VINEGAR INDUSTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

Notwithstanding the fact that the manufacture of vinegar is one of the oldest industries in this country, and that in London alone there is an output of several million gallons a year, it is surprising how little is known by the outside world of the way in which it is made.

This is largely the result of the policy of secrecy with which each firm of vinegar-makers jealously guarded its methods during the last century; although, as they were working upon practically identical lines, they had little to conceal from one another.

To such a pitch was this craze for secrecy carried that some of the firms made use of thermometers with marks upon them instead of a scale, while others went even further, and deceived their workmen by the use of thermometers in which the scales were of set purpose graduated incorrectly.

In all the British factories, which in the year 1840 numbered forty-eight, the methods of working had been handed down within the works themselves, and few attempts were made to reduce to a minimum the chemical and mechanical losses inevitable during the manufacture.

During the last quarter of a century, however, there has been a great improvement in this direction, and many of the factories now have up-to-date apparatus and are under scientific direction, though numerous examples of the primitive works, universal fifty years ago, still survive.

There has been little alteration in the general principles of manufacture in any of the works, the process still following the three stages of preparing a saccharine infusion of a cereal, of fermenting the sugar in this into alcohol, and of transforming the alcohol into acetic acid by the action of bacteria.

Although wine vinegar is made to a small extent in this country, the product chiefly sold is derived from malt, or from a mixture of malt with grain or sugar, and would therefore be more correctly described by the now obsolete term *alegar*.

The first stage of its manufacture is very similar to the *mashing* process in a brewery. The malt, or mixture of malt and grain, is first crushed between rollers and heated in a mash-tun with water at a gradually increasing temperature, until, after two to three hours, the whole of the starch in the grain has been converted into sugar by the enzyme, diastase, present in the germ of the malt.

When this conversion is complete the *wort*, as the infusion is now termed, is drawn off, and, without being boiled with hops, as in the case of beer, is transferred to a fermenting tun, and treated with a suitable yeast.

In some vinegar works the wort is obtained by means of the *conversion process*, instead of by mashing. In this process the grain, usually rice or maize, without malt, is treated with dilute mineral acid, such as sulphuric acid, in a closed vessel termed the *converter*. Under suitable conditions the acid hydrolyses the starch in a manner analogous to that of the diastase of malt, and produces a saccharine solution, which, after neutralisation of the residual acid with calcium carbonate and separation of the resulting insoluble calcium sulphate, is ready for fermentation.

By whichever method obtained, the wort is now *pitched* with yeast, and is aërated and kept at the best temperature to convert as much as possible of the sugar into alcohol. Upon the successful working of this stage of the process largely depends the subsequent strength of the vinegar, since all saccharine matter (including dextrins) which has escaped the action of the yeast, will also remain unaffected by the acetic bacteria. The fermented wort (now termed *gyle*), which usually contains about six or seven per cent. of alcohol, is now ready for the third stage—the conversion of this alcohol into acetic acid. This is brought about by the action of specific bacteria, termed acetic bacteria, which convey oxygen from the air to the alcohol, and transform it into acetic acid. The reaction that takes place in the process is usually represented by the formula—

$$\underset{\text{Alcohol}}{C_2H_6O} + \underset{\text{Oxygen}}{O_2} = \underset{\text{Acetic Acid}}{C_2H_4O_2} + \underset{\text{Water}}{H_2O}$$

though, in practice, many other compounds are formed, in addition to aldehyde, which is probably invariably produced as an intermediate stage in the oxidation—

$$\underset{\text{Alcohol}}{C_2H_6O} + \underset{\text{Oxygen}}{O} = \underset{\text{Aldehyde}}{C_2H_4O} + \underset{\text{Water}}{H_2O}$$

FIGURE 1.

B. Kützingianum. (Hansen).

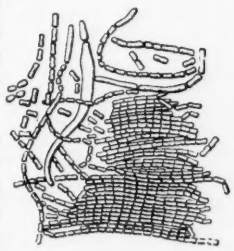

FIGURE 2.

B. aceti. (Hansen.)

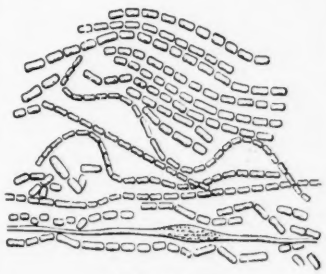

FIGURE 3.

B. pastorianum. (Hansen).

Species of Acetic Bacteria multiplied by 1000.

The exact part played by the bacteria in this process is still obscure, and it has not yet been ascertained whether the bacteria consume the alcohol and excrete it as aldehyde and acetic acid, or whether they contain an enzyme, the function of which is to act, as platinum black can do (possibly by setting up suitable vibrations in the alcohol), as a carrier between the oxygen and the alcohol.

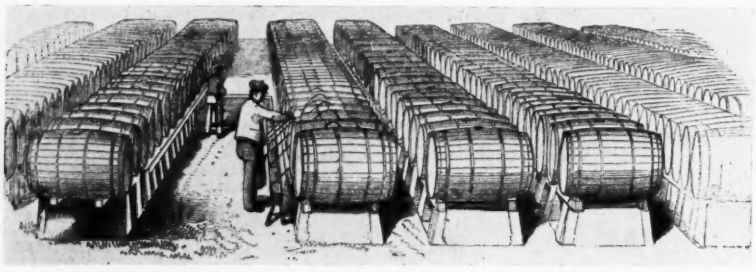

FIGURE 4.
Vinegar Fields in the year 1800. Drawing off the Vinegar.

The isolation of the enzyme, *zymase*, from yeast, and the proof that even in the form of a dry powder it could ferment sugar into alcohol, led to repeated efforts to isolate an analogous oxidising enzyme from acetic bacteria; but, as yet, all such attempts to express from the ruptured cells a liquid which after filtration should produce the effect of the living bacteria, have ended in failure. Several species of acetic bacteria have been isolated, differing from one another in their form, in the temperatures at which they work best, and in the nature of the products that they yield. Of these the best known are the three species first studied in 1894 by Hansen and shown in the accompanying illustrations. (See Figures 1, 2 and 3.)

All are characterised by the different involution forms which they assume when cultivated upon a suitable medium, under different conditions. In each case when grown upon the surface of a nutrient liquid, such as wort, at a temperature of about 34° C. (93° F.), they form pellicles upon the surface, but the skin thus produced differs in appearance, that of *B. aceti* being moist, smooth, and slimy, while that of *B. pastorianum* is dry, and has a corrugated surface.

In the case of *B. Kützingianum* the cells are, as a rule, isolated, and the formation of chains rarely occurs, whereas the occurrence of separate cells is the exception in the case of the other two species. The cells of *B. aceti* are narrower than those of the others, and not infrequently show a form resembling a figure-of-eight, as was first noticed by Pasteur.

The pellicle or skin formed by all these bacteria is what is termed a zoögloeal form, and consists of the cells united together into a mass by the swelling and fusion together of the outside cellular membranes.

Popularly it is known as *mother-of-vinegar*, and its excessive development in the worts is an indication that insufficient air is being supplied to the bacteria.

The apparatus in which originally this acetic fermentation was effected consisted of nothing more than barrels filled with wood shavings, through which the wort, after being mixed with a little finished vinegar containing the acetic bacteria, was allowed to trickle. Hundreds of these casks were ranged above pipes communicating with the gyle store vats, and were filled by means of a flexible hose connected with the pipe. Each day the bungs were uncovered, if the weather was fine, in order to admit a fresh supply of air to the interior of the cask, this process being continued for many weeks until the acetification was complete.

The accompanying illustration (see Figure 4) represents a portion of the largest of these vinegar fields (those of Messrs. Beaufoy & Co.) at the beginning of the nineteenth century.

FIGURE 5.
A "Sending-out" Warehouse. Beaufoy's Vinegar Warehouse in the year 1800.

As these fields necessarily covered a very large area they were obviously little suited for places where land was valuable. Apart from that, *fielding*, as it was termed, was a very slow process of acetification, and involved heavy wastage.

Hence, when, in 1823, Schützenbach devised a

more rapid method of acetification, his apparatus was speedily adopted in Europe, and more slowly in this country.

The acetifiers employed in what was then termed the *quick* process consisted of large vats holding from two thousand to three thousand gallons each. About two-thirds of the way down they were provided with a perforated false bottom, and the whole of the space above was filled with beech shavings, while holes for the admission of air were made in the side of the vat, just above the false bottom, and smaller holes for its escape in the top.

The gyle was constantly pumped over from the bottom of the vat to the top, and trickling down through the shavings met with a current of air, which was drawn into the vat, under the influence of the heat promoted by the reaction. About three weeks were required for the complete conversion of the alcohol into acetic acid.

The acetifying apparatus used at the present day, is essentially the same as that of Schützenbach, the chief differences being in the nature of the packing material placed in the vat, and in the method of distributing the gyle over the surface at the top, so as to insure its reaching all parts of the aërating medium.

In most acetifiers a sparger is used for sprinkling the liquid over the material, and basket work is commonly employed in place of wood shavings. The principle of the sparger is shown in Figure 6, which represents a section of the upper portion of an acetifier.

The liquid is pumped from the bottom of the vat and discharged into the funnel at the top, this funnel being boxed in to prevent loss by evaporation. Thence it flows down through the tube G, into the sparger R, which revolves smoothly upon a pivot S. In the arms of the sparger are a number of small holes through which the liquid passes, and thus causes the sparger to revolve steadily and to sprinkle uniformly the whole of the surface of the basket work, which is also shown in the figure.

A thermometer inserted through a hole in the side of the acetifier shows the temperature within the apparatus, and affords an indication whether the acetification is following a normal course.

No more striking illustration of the manner in which scientific text-books will copy errors from one another can be found than in the assertions that are put forward as to the temperatures at which acetic bacteria thrive the best.

This is commonly given as about 90° to 95° F., and according to Brannt, "the formation of vinegar ceases entirely at 104° F." Yet the writer has frequently seen the thermometers record a temperature of 110° F., and there is no doubt that in this country, at all events, the bacteria are most active at a temperature of about 105° F. Possibly, this may be the result of adaptation to the surrounding conditions, since in Continental vinegar works the temperature of the acetifiers seldom exceeds 95° F.

The conditions for successful working are, firstly a regular and uniform supply of air, and secondly the right temperature. If too much air is admitted the bacteria will oxidise part of the acetic acid they have produced and a weak vinegar will result. If too little air is available the acetification proceeds very slowly, the bacteria form themselves into the zoögloeal condition mentioned above, and the acetifier becomes clogged with slimy masses which still further stop the passage of the air, so that it forms currents in one portion instead of effecting uniform aëration.

However carefully the process may be carried out, the reaction never proceeds quantitatively in practice, and the loss of acidity, due to evaporation of the alcohol and irregular aëration resulting in the destruction of acetic acid, usually ranges from ten to twenty per cent., and may, in very faulty apparatus, reach as much as thirty per cent.

Most of the modern patents have had for their object the remedying of these defects. Thus, in some types of acetifiers, the air issuing from the apparatus is carried back again into the vat, the idea being, that the volatile constituents of the vinegar will thus be prevented from escaping.

In others, attempts have been made to accelerate the speed of oxidation, and thus reduce the period of loss, by the introduction of ozonised air, but these do not appear to have met with much success.

The key to the problem appears to be the provision of a sufficiently large aërating medium through which the air can circulate with absolute uniformity, and experiments on a large scale, made by the present writer, have shown that so long as these conditions can be maintained, the conversion of alcohol into acetic acid proceeds almost in accordance with the theoretical requirement.

After the vinegar leaves the acetifiers it is stored for some time to form the ethers to which it owes its aroma, and is then clarified by filtration through large vats containing a suitable filtering medium, such as fine sand. Finally it is diluted to the required strengths, and is sent out to the trade.

From the days of Charles II. to the reign of William IV. vinegar was under the control of the Excise, and paid duty in accordance with its acetic strength, which was determined by the Excise Officers by means of a special hydrometer, the vinegar being first neutralised by the addition of pure calcium carbonate. Not until the year 1836 did vinegar cease to be tested by the Excise Officials.

As it leaves the filtering vats, vinegar has an acetic strength of 6 per cent., and upwards, and is termed "24 Vinegar." Originally this name indicated that one fluid ounce required 24 grains of sodium carbonate to neutralise its acidity, but in the trade the name is now applied to vinegars containing 5·5 per cent. of acetic acid and upwards. In like manner, the lower strengths of vinegar are known as "16," "18," "20," and "22," the lowest of these containing 4·1 per cent. of acid.

There is no legal standard as to the permissible

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dilution of vinegar, and a cheap vinegar containing 3·5 per cent. of acetic acid is often sold under the name of "Diamond." A recommendation was recently made, however, in a report to the Local Government Board that vinegar containing less than 4 per cent. of acetic acid should not be sold, and there is a general tendency on the part of vinegar manufacturers to accept this standard, which has been upheld in undefended cases in the police courts.

With regard to what should be the composition of the other constituents in vinegar, there is no agreement either among manufacturers themselves or among scientific authorities. Should malt vinegar be brewed entirely from malted barley, or is any sort of malted grain permissible? According to the old Pharmacopoeia malt vinegar was to be brewed from a mixture of malted and unmalted grain, and if this is accepted, rice must be regarded as quite as admissible as barley. Again, maize is largely used by vinegar makers, but the opinions of authorities differ upon the point whether glucose derived from maize is permissible.

All these variations in the materials used affect the final composition of the solid matter in the vinegar, and prevent the analyst from drawing deductions as to the origin of the product.

Thus a vinegar made entirely from malt will contain a considerable proportion of phosphates and nitrogenous substances, whereas in a rice vinegar the amounts of these constituents will be very much less, and, in the absence of special knowledge to the contrary, such a vinegar might very well be certified as containing added acetic acid.

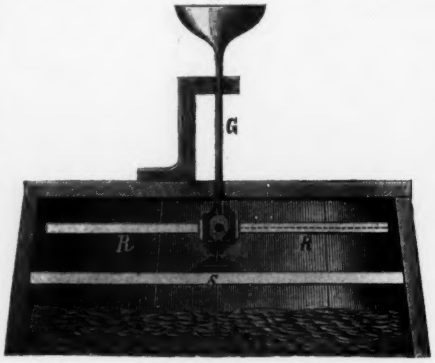

FIGURE 6.
Section of Upper Part of a Modern Acetifier.

The so-called "wood vinegar," which consists of acetic acid obtained by the destructive distillation of wood and coloured with caramel, is a perfectly wholesome article, and no objection need be taken to its sale under its own name. The legitimate vinegar maker has, however, to meet the competition of the "vinegar faker," who with the aid of no other plant than a barrel of acetic acid and a keg of caramel, is able to put upon the market a product which he sells at a cheap price under such titles as "Double refined malt vinegar." The occasional prosecution of the retailers of these concoctions does little to check the evil, for the "manufacturer" promptly leaves his "works," usually a back yard, and cannot be found. It is not long, however, before he re-appears under another name, and continues to meet the popular demand for "pure malt vinegar" at a price at which it could not possibly be made.

NOTICES.

A NEW PHONOGRAPH.—M. Lifschitz, a young Russian scientific man now working in Paris, has invented a phonograph which uses photography for recording the vibrations of human voice.

He began his experiments in Russia but has continued them in M. Dastre's laboratory at the Sorbonne, and there a demonstration has been given before a small gathering of the friends of science with a rough model constructed by the inventor and M. Victor Henry.

The sonorous vibrations of the voice striking a membrane are thrown in the form of luminous images by a small mirror upon a sensitive photographic film travelling at a high speed as a band, and describe a curve upon it. Where the light acts on it, the film is rendered hard and insoluble. The other parts remain soft, and may be washed away.

For reproducing the voice the band passes before a "fente" behind which is a chest of compressed air. As the hollows of the curve move rapidly before the "fente" the air as it escapes reproduces the vibrations which caused them—in other words it reproduces the vibrations of the human voice.

The word "curve" is used here in its scientific sense. There are, in fact, "makes" and "breaks." Theoretically, the membrane which actuates the mirror may be dispensed with.

M. Dastre is convinced that the new phonograph when properly constructed, will give results far above those yielded by mechanical phonographs of the Edison type.

Photographing vibrations is not new. What is new is the combination of principles and the method of reproducing the results of the photography.

P. E. K.

STONYHURST COLLEGE OBSERVATORY. — The Report of the Director, Rev. W. Sidgreaves, S.J., F.R.A.S., for 1910, just to hand, shows a good record of work. It was found that "the year's mean barometric pressure was a little below the average, and of the month means only those of March, September and October were above their respective averages. These also were the drier months, the only ones in which the rainfall was below the monthly average. But the duration of sunshine was less than the average in September and October. The highest reading of the barometer occurred in March, and the lowest in February. The former was a fine dry month, the latter remarkable for its number of rainy days, the greatest number recorded for February in sixty-three years." During the same period no January has shown so great a rainfall as this, 8·043 inches, nor so great a fall in one day as on the 15th, when 2·07 inches were recorded. Of the one hundred and sixty-six days on which the Sun was observed the disc was free from—presumably dark—spots on no less than forty, and drawings were made on the remaining one hundred and twenty-six. The mean daily area covered by spots (1 being equivalent to $\frac{1}{50000}$th of the visible surface) fell from 3·8 in 1909 to 1·8 in 1910. It is, however, remarkable that the daily declination range of the magnetic needle increased from 13·5 in 1909 to 14·5 in 1910. During the year no very great magnetic disturbances were recorded, though January 25th, March 27th, 28th and 30th, April 1st and 27th, June 8th, 19th and 20th, August 9th, 21st, 22nd and 28th, September 29th, October 4th, 6th, 12th and 27th, and December 28th, are all recorded as great.

F. C. D.

THE FACE OF THE SKY FOR JUNE.

By W. SHACKLETON, A.R.C.S., F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.51 and sets at 8.4; on the 30th he rises at 3.48 and sets at 8.18. Summer commences on the 22nd, when the Sun enters the sign of Cancer at 1.35 p.m.; this is the longest day, the Sun being $16^h\ 34^m$ above the horizon. The equation of time is negligible on the 15th; hence this is a convenient day for adjusting sundials, as only the correction for longitude is needed. Sunspots and prominences are not very numerous; at the time of writing no spots are visible. The positions of the Sun's axis, equator, and heliographic longitude of the centre of the solar disc are shown in the following table. An example of a disc suitable for solar projection was shown on page 200 of the May issue.

Date.	Axis inclined from N. point.	Centre of Disc S. or N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
May 31 .	16° 5′W	0° 43′S	115° 59′
June 5 ...	14° 11′W	0° 6′S	49° 49′
,, 10 ...	12° 11′W	0° 30′N	343° 38′
,, 15 ..	10° 5′W	1° 6′N	277° 28′
,, 20 ...	7° 55′W	1° 41′N	211° 16′
,, 25 ...	5° 40′W	2° 16′N	145° 5′
,, 30 ...	3° 25′W	2° 50′N	78° 55′
July 5 ...	1° 8′W	3° 23′N	12° 44′

THE MOON:—

Date.	Phases.	H. M.
June 3 ...	☽ First Quarter	10 4 p.m.
,, 11 ...	○ Full Moon	9 51 p.m.
,, 19 ...	☾ Last Quarter	8 51 p.m.
,, 26 ...	● New Moon	1 20 p.m.
July 3 ...	☽ First Quarter	9 20 a.m.
June 11 ...	Apogee	10 42 p.m.
,, 26 ...	Perigee	3 6 a.m.

OCCULTATIONS.—The only naked eye star occulted before midnight is the fifth magnitude star 22 Scorpii; disappearance takes place on the 10th at 9.38 p.m. at an angle of 90° from the N. point of the Moon, and reappearance at 10.55 p.m. at an angle of 312°.

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
June 1 ..	2 57	N 13° 6′
,, 11 ...	3 44	17° 11′
,, 21 ...	4 54	21° 49′
July 1 ...	6 24	24° 21′
,, 11 ...	7 56	N 22° 37′

Mercury is a morning star in Taurus during the early part of the month. On the 1st the planet rises in the E.N.E. at 3.10 a.m.; on this date Mercury is at greatest westerly elongation of 24° 30′, from the Sun, but the elongation is an unfavourable one on account of the planet only rising 40 minutes in advance of the Sun.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
June 1 ...	7 36	N 24° 0′
,, 11 ...	8 23	21° 42′
,, 21 ...	9 7	18° 35′
July 1 ...	9 47	14° 52′
,, 11 ...	10 22	N 10° 46′

Venus is a brilliant object in the evening sky looking W.N.W. immediately after Sunset.

The planet is extremely well placed for observation, appearing high above the horizon at Sunset and not setting till 11.20 p.m. on the 1st and 10.37 p.m. on the 30th. Moreover, the planet can readily be seen long before it is dark and even in broad daylight a small pair of opera glasses is sufficient optical aid to render it visible if directed to the correct position in the sky. The best time for observing is whilst the background of the sky is still light, for the brightness of the planet is so intense that it requires an uncommonly good telescope to observe when dark, partly because the planet is then lower in the sky and partly on account of the luminosity of the planet being strong enough to reveal any lack of achromatism in the telescope; thus in poor instruments a blue halo frequently appears to surround the image. With magnifying powers of 150 to 250, dark shadings may be seen on the planet's disc towards the terminator, the limb appearing intensely brilliant. As seen in the telescope the planet appears slightly gibbous 0·6 of the disc being illuminated, whilst the diameter of the disc is about 20″. The Moon appears near the planet on the evening of the 29th.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
June 1 ...	23 59	S 2° 10′
,, 11 ...	0 26	N 0° 38′
,, 21 ...	0 52	3° 23′
July 1 ...	1 18	6° 1′
,, 11 ...	1 44	N 8° 29′

Mars is a morning star in Pisces, rising nearly due E. early in the month, and later a little N. of E. On June 1st, the planet rises about 1.30 a.m., and on July 1st, about ten minutes after midnight. The planet is increasing in brightness the apparent diameter being now nearly 8″. On the morning of

FIGURE 1.
Conjunction of Mars and the Moon, June 21.

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the 21st, at 1 a.m. the Moon is in conjunction with the planet, Mars being only 0° 12′ to the north (see Figure 1).

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
June 1 ..	14 17	S 12° 19′
,, 11 ...	14 14	12° 7′
,, 21 ...	14 12	11° 59′
July 1 ...	14 11	11° 58′
,, 11 ...	14 12	S 12° 3′

Jupiter is a brilliant object in the evening sky looking South, and is in the very best position for observation. Near the middle of the month the planet is on the meridian at 8.45 p.m., but observations may commence as soon as it is dark, since he is above the horizon at Sunset.

The planet is describing a retrograde path near α Virginis and is at the stationary point on July 3rd.

The most noticeable features as seen in the telescope are the moons, the dark belts, and the polar flattening; this latter is shown by the equatorial diameter being 41″·6 and the polar diameter 2″·7 less. If sufficient magnifying power be used with a telescope of about four inches aperture, markings and also the "Great Red Spot" on the belts may be observed, from which the period of rotation may be deduced. This is only $9^h\ 55^m$, which explains the cause of the oblateness of the planet.

The following table gives the satellite phenomena visible before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
June				June				June			
1	I.	Tr. E.	9 44	9	II.	Ec. R.	11 38	23	I.	Oc. D.	10 8
1	I.	Sh. E.	10 28	11	III.	Ec. R.	9 38	24	I.	Tr. E.	9 36
8	I.	Tr. I.	9 20	15	I.	Tr. I.	11 8	24	I.	Sh. E.	10 41
8	I.	Sh. I.	10 10	16	II.	Oc. D.	9 42	25	II.	Sh. E.	11 19
8	I.	Tr. E.	11 31	16	I.	Ec. R.	11 26	25	III.	Oc. D.	11 42
9	I.	Ec. R.	9 32	18	III.	Oc. R.	9 42				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

The configurations of the satellites as seen in an inverting telescope and observing at 11 p.m. are as follows:—

Day.	West.	East.	Day.	West.	East.
1	4321 ○		16	43 ○	●2 ●1
2	34 ○	21	17	431 ○	2
3	31 ○	4 2	18	42 ○	3 1
4	2 ○	314	19	241 ○	3
5	4/1 ○	34	20	○	4123
6	○	1234	21	1 ○	2/3 4
7	1 ○	2/3 4	22	23 ○	14
8	32 ⊙	4	23	32 ○	4 ●1
9	3 ○	14 ●2	24	31 ○	24
10	31 ○	24	25	23 ○	1 4
11	2 ○	3/4 1	26	21 ○	34
12	4/1 ○	3	27	○	1/2 43
13	4 ○	123	28	14 ○	2/3
14	41 ○	2/3	29	423 ○	1
15	423 ○	1	30	4321 ○	

The circle (○) represents Jupiter; ⊙ signifies that the Satellite is on the disc; ● signifies that the Satellite is behind the disc, or in the shadow. The numbers are the numbers of the Satellites.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
June 1 ...	2 47	N 13° 53′
,, 16 ...	2 54	14° 22′
July 1 ...	3 0	N 14° 47′

Saturn is a morning star in Aries, rising E.N.E., about 3 a.m., on the 1st June, and at 1.7 a.m. on the 30th. In consequence of the planet being in a bright portion of the sky he is, for all practical purposes, unobservable.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
June 1 ...	20 5 14	S 20° 53′ 49″
July 1 ..	20 1 28	S 21° 5′ 33″

Uranus rises in the S.E. at 11.20 p.m. on the 1st, and at 9.23 p.m. on the 30th. The planet is unfavourably placed for observation, as he is low down in the sky; he is describing a retrograde, or westerly, path, about 2° S.E. of σ Capricorni; he can just be discerned with the naked eye on a very clear night, but is easily visible through a pair of opera glasses.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
June 1 ...	7 25 15	N 21° 24′ 49″
July 1 ...	7 29 33	N 21° 16′ 20″

Neptune is practically unobservable as he sets at 11 p.m., on the 1st and at 9 p.m. on the 30th.

METEOR SHOWERS:—

Date.	Radiant.		Name.	Characteristics.
	R.A.	Dec.		
	h. m.			
June–July ...	16 48	−21°	*a* Scorpiids	Fireballs.
June 13 ..	20 40	+61°	*a* Cepheids	Streaks, swift.

Mira (ο Ceti) is due at maximum on the 30th, but observations should be made before and after this date as the period is somewhat variable. The magnitude at maximum is usually about 3·0 but this, too, is variable. The spectrum at maximum is a mixed one exhibiting both bright and dark lines.

TELESCOPIC OBJECTS:—

DOUBLE STARS, &c.—γ Virginis XII.^{h} 37^m, S. 0° 54′, mags. 3, 3, separation 6″·0. Fine double for small telescopes with a magnification of about 80.

β Scorpii, XVI.^{h} 0^m, S. 19° 34′, mags. 2·7, 5·2; separation 13″.1.

ε Lyrae, XVIII.^{h} 41^m, N. 39° 33′, known as the "double-double" star, can just be separated by the naked eye, but with a pair of opera glasses it is readily divided into two components, ϵ_1 and ϵ_2, mags. 4·4 and 4·8. Using a 3-in. telescope and a power of about 120, each of these stars can again be divided into pairs, 3″·2 and 2″·6 apart respectively, each component being about magnitude 5·5.

M 57 (Lyra), the "ring" nebula. This nebula is the only annular nebula accessible to telescopes of about 3-in. aperture, and even then requires good seeing. It is easily found, being situated about ⅓ of the distance from β to γ Lyrae. The usual appearance in a 3-in. telescope is that of a rather large

nebulous star, but it bears magnification well, and its annular character can easily be made out with a moderately high power.

M 80 (Scorpio). A compact globular cluster half way between α and β Scorpii; looks like a nebula in small telescopes.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed here.

QUESTIONS.

41. THE EFFECT OF RIGID RAILS ON THE SPEED OF A TRAIN.—A pendulum shows that, as one walks towards it, one makes a dimple in the ground.

I have often observed the dimple which is made by a running locomotive.

As the engine is continually climbing out of consecutive dimples, a question arises—is the speed of a train lessened thereby, and would the train travel faster if the rails were absolutely rigid?

FRANCIS RAM.

42. THE CARRION CROW.—Can any of your readers inform me whether a clutch of nine crow's eggs has been recorded? I found a nest in the Brent Valley this Spring containing eight greenish-brown eggs and one greenish-grey. The eight were at the bottom of the nest, and the other on top of the others.

GEOFFREY KER WEBB.

43. ASTRONOMY.—Of what value is "Urania's Mirror, or a View of the Heavens" (published by Sleigh), consisting of 32 coloured plates, engraved by Sid. Hall, sculptor?

A. M. F.

REPLIES.

31. It has never come to my ears nor eyes that wireless telegraphy did or would have anything to do with changes in the weather, but to me it seems feasible and likely.

The entire universe is built upon vibrations, and electrical forces and storms are no exception. If it is true that wireless telegraphy may, in a measure, influence weather conditions, it is because of the vibrations of the electric and air waves it sends forth from the central station. Of course, the greater the electricity generated the greater the change in the weather. I can go no further and state why these vibrations should cause any change in the weather, but will give a few examples we have all seen or heard.

A heavy peal of thunder during an electrical storm—one that jars the house and shakes the windows—is, in almost all cases, followed by a heavy downpour of rain. The terrible convulsions of the atmosphere during tornadoes, frequent in the southern states of the United States and the hurricanes of the West Indies, are invariably followed by torrential rains. Whirlwinds coming out of a clear sky are immediately followed by clouds and storminess. The fair weather preceding an earthquake is quickly changed, after the vibrations and tremors of the earth, into cold, cloudy and rainy conditions. After all great battles, where heavy cannonading has been going on for any length of time, rain is sure to fall with the gathering of clouds soon after. Even during the American Independence celebration, rain generally falls at night in the places where the most fireworks have been set off, no matter how clear the weather had been during the day. Allow me to go one step farther and say that all the planets, as electric dynamos, are sending forth vibrations throughout space which causes the ocean tides and the varying storm and weather conditions upon ours and other whirling globes.

L. N. PRITCHARD.

39. ANTICYCLONE.—It is quite true that an anticyclone is not always the opposite of a cyclone as regards the actual strength of the wind, but there are certain properties of these systems which make them diametrically opposed. (1) The wind circulation is anti-clockwise in a cyclone, but clockwise in an anticyclone. (2) Pressure is highest at the centre of an anticyclone, but lowest at the centre of a cyclone; and, therefore (3) the wind circulates spirally outwards in an anticyclone, but spirally inwards in the case of a cyclone. (4) Comparatively speaking the calmest area of an anticyclone is at its centre, whereas the windiest area of a cyclone is at its centre. Thus the term "anticyclone" does not *always* infer quiet weather. There is sometimes a difficulty in that there is no hard and fast boundary between the edge of an anticyclone and that of a cyclone; one cannot always say how much of the wind's strength is due to one system or the other. Thus the term "anti" is justified in four respects, not to mention the fact that an anticyclone usually drifts or remains stationary, whereas a cyclone generally has a much faster motion in a certain direction.

C. H. E. RIDPATH.

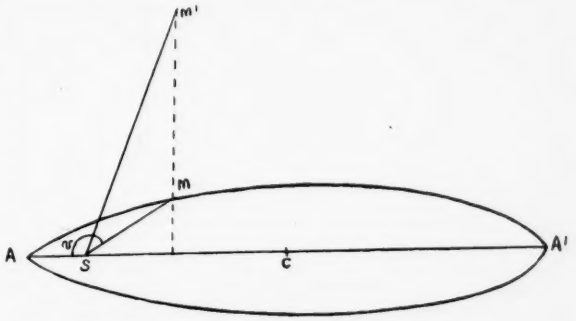
40. WATER-FINDING.—No scientific explanation is yet attainable. The supposition of those who have most thoroughly studied the phenomena is that some people can sub-consciously perceive underground water, and so on, by a kind of sixth sense, and that the sub-consciousness signals its discovery by twitching the muscles and thus moving the rod. The only scientific treatment of the subject at any length is in Professor W. F. Barrett's reports in the "Proceedings" of the Society for Psychical Research, Vols. 13 and 15. A condensation is given in his pamphlet "On the History and Mystery of the so-called Dowsing or Divining Rod," obtainable for 1s., from the Secretary, Society for Psychical Research, 20, Hanover Square, London, W.

J. ARTHUR HILL.

33. HALLEY'S COMET.—"Interested" asks a question with reference to the determination of the distance of Halley's Comet from the Sun, and also its velocity, at any time, say two years after passing Perihelion, April 19th, 1912.

The following easy method can be used, when the perturbations of the planets are not taken into consideration.

Let the figure represent the path of the Comet in its orbit, where AA^1 is the axis major of the ellipse described, S the Sun in one of the foci of the ellipse, C the centre, and M the Comet two years after passing perihelion. Of course A will represent perihelion point.



We assume the following data in connection with Halley's Comet:—

Periodic time	...	76·37 years.
Perihelion distance	...	·5889 Astronomical Units.
Eccentricity	...	·967
Aphelion distance	...	35·411 Astronomical Units

The angle ASM described by the radius vector is called the "True Anomaly," and is generally denoted by v; the angle described by the radius vector on the assumption that it moves uniformly, is called the "Mean Anomaly"; it is usual to denote it by M. Now, if we suppose a circle circumscribed

round the ellipse, and we draw through M an ordinate meeting this circle in M^1, the angle ASM^1 is called the "Eccentric Anomaly," denoted by u.

From the properties of an ellipse the equation

$M = u - e \sin u$ is easily deduced, where e is the eccentricity.

Now $M_1 = \frac{360^\circ}{76 \cdot 37} \times 2 = 9^\circ\ 25'\ 40''$

$\therefore 9^\circ\ 25'\ 40'' = u - \cdot 967 \times 57^\circ \cdot 3 \sin u.$

The factor $57^\circ \cdot 3$ is introduced, since this is the number of degrees in one radian.

This equation can be solved approximately by a Graphic Method; the one used is the well-known method by drawing a Curve of Lines. As a first approximation u comes out about 55°.

To find its exact value, let u be actually $55^\circ + \theta^\circ$, where θ is small.

$\therefore 9^\circ\ 25'\ 40'' = 55^\circ + \theta^\circ - \cdot 967 \times 57 \cdot 3 \sin (55^\circ + \theta^\circ).$

Now $\sin (55^\circ + \theta^\circ) = \sin 55^\circ \cos \theta^\circ + \cos 55^\circ \sin \theta^\circ$

$$= \sin 55^\circ + \frac{\theta^\circ}{57 \cdot 3} \cos 55^\circ,$$

since $\cos \theta = 1$ nearly, and $\theta = \frac{\theta}{57 \cdot 3}$ as θ is very small.

We, therefore, obtain $45^\circ\ 34'\ 20'' + \theta^\circ =$

$$\cdot 967 \times 57 \cdot 3 \left(\cdot 81915 + \frac{\cdot 57358}{57 \cdot 3}\ \theta^\circ \right);$$

or $\theta^\circ + 45 \cdot 57222 = 45 \cdot 387 + \cdot 55467\ \theta^\circ$

$\cdot 44533\ \theta^\circ = - \cdot 185$

$\therefore \theta^\circ = - \cdot 4157^\circ = - 24'\ 26''$

Hence, value of u is $55^\circ - 24'\ 26''$

$= 54^\circ\ 35'\ 34''.$

The True Anomaly v is given by the formula

$$\tan \tfrac{1}{2} v = \sqrt{\frac{1+e}{1-e}} \tan \tfrac{1}{2} u$$

$= 7 \cdot 72 \tan 27^\circ\ 17'\ 47''$

$= 7 \cdot 72 \times \cdot 51606 = 3 \cdot 9814$

$\therefore \tfrac{1}{2} v = 75^\circ\ 54'$

or $v = 151^\circ\ 48'$ approximately.

If n be the distance of the Comet from the sun, r is given by the formula $r = a(1 - e \cos u)$, where a is the semi axis major, or 18 astronomical units

$\therefore r = 18 (1 - \cdot 967 \cos 54^\circ\ 35'\ 34'')$

$= 18 (1 - \cdot 56028)$

$= 7 \cdot 91496$

Its distance from the sun would, therefore, be about eight times the distance between the sun and the earth. It would be, at this time, between the orbits of Jupiter and Saturn.

The formula to determine the velocity at any point in the orbit distant r from the sun is

$$V^2 = \frac{2\mu}{r} - \frac{\mu}{a}$$

where μ is a constant, and a the sun's axis major. Substituting $7 \cdot 91$ for r, and 18 for a, we find

$$V^2 = \cdot 1979\ \mu$$

$$\therefore V = \cdot 445\ \sqrt{\mu}$$

The constant μ can be found from a consideration of the motion of the earth in its orbit. Since the comet describes an ellipse around the sun, μ will be the same for the earth and the comet. Using the equation

$$V^2 = \frac{2\mu}{r} - \frac{\mu}{a}$$

for the earth, and remembering that r = a very nearly, since the eccentricity of the earth's orbit is only $\frac{1}{60}$, we have

$$V^2 = \frac{2\mu}{a} - \frac{\mu}{a} = \frac{\mu}{a}$$

Now, the velocity of the earth around the sun is about eighteen and a quarter miles a second, and $a = 1$ astronomical unit, therefore $\mu = (18 \cdot 25)^2$, or $\sqrt{\mu} = 18 \cdot 25$. Substituting in the expression $V = \cdot 445\ \sqrt{\mu}$, we have $V = \cdot 445 \times 18 \cdot 25 = 8 \cdot 12$ miles per second.

The perturbations produced by the planets will slightly alter some of the elements, but the above results may be taken as approximately correct.

(REV.) M. DAVIDSON.

POSTAL REFORM.

THE cost of postage presses very heavily upon magazines which cannot be registered as newspapers, and it seems rather hard that a newspaper weighing several pounds can be transmitted through the post for a half-penny, when scientific journals and the transactions of societies, which tend to the spread of knowledge, and the advancement of science, may cost six, or eight, or ten times as much. We have therefore much pleasure in printing the resolutions which were passed unanimously at a large and influential meeting, convened by Mr. Edward Owen Greening, on April 6th, at the offices of the Horticultural and Agricultural Association, and we are sanguine that at last some real good may be done.

1. "That this representative gathering of proprietors, publishers, and editors of magazines and trade journals earnestly protests against the present unfair, unequal, and excessive postal rates upon periodicals published at intervals longer than a week, the British Post Office arrangements being more oppressive than those of any other civilised countries in postal charges on this important kind of literature. The present postal treatment, by restricting circulation of magazines, depresses the remuneration of authors and artists, renders it difficult for British publishers to compete with those of other countries; enhances prices to the public, and reduces the benefits which can be given to readers of such periodicals which are largely instructors in matters of science, art, manufactures, commerce, philanthropy, and religion."

2. "That in view of the huge surplus profits on postages amounting to five millions sterling per annum, and averaging over 26 per cent. on the business, we cannot accept the declaration of the postal authorities that they are unable to afford reform. We deprecate postal forecasts of possible losses on reductions, as these gloomy anticipations are always falsified in results. We claim that postal revenues are properly applicable to postal purposes, and should be used to reform evils, remove anomalies, and redress grievances of the public which uses the Post and the employés who serve it. We regard the abstraction of postal revenues by the Exchequer as a virtual act of confiscation, degrading the Post Office from its proper position into a tax-collecting department of the Government. We demand that fair treatment shall be given to us, equal to that enjoyed by publishers in America, Canada, and so on, before the postal surpluses to which we contribute are alienated by the Exchequer."

3. "That we, now present, pledge ourselves to form an organisation to press for the necessary postal reforms, and to supply resources for an effective movement.

"That we appeal to all magazine proprietors and editors regularly to devote space in their columns to public enlightenment on the questions at issue. That we appeal to our colleagues of the daily and weekly journals for their good help. That we seek the aid of friends of the Press in the Legislature to organise active Parliamentary action."

4. "That a General Committee be elected with powers to add to their number, to appoint an Executive and officers: to increase adherents to the cause by canvass and otherwise conduct our movement to a successful issue."

XUM

THE BRINE SHRIMP.

By W. T. CALMAN, D.Sc.

THE pretty little Crustacean known as the Brine Shrimp was first discovered about the middle of the eighteenth century at Lymington, in Hampshire. In those days, and for something like a century afterwards, the manufacture of salt from sea water was carried on there and at other places on our coasts, the first stage of the process being the concentration of the sea-water by exposing it to evaporation by the heat of the sun in large shallow ponds. The concentrated brine was then run into open vats known as "salterns," previous to being further evaporated by artificial heat, and it was in these vats that the Brine Shrimps, or "brine-worms" as they were called, appeared in such numbers as to give the brine a reddish tinge. They were believed to be of service in clearing the liquid from impurities, and the workmen were in the habit of transferring some of them from one "saltern" to another, when they did not make their appearance naturally, to ensure their presence when the brine had reached the proper degree of concentration. Brine Shrimps have since been found in many parts of the world in natural or artificial brine-pools and lagoons and in salt lakes, and, although a number of species have been described, there is reason to believe that they are all forms of a single variable and cosmopolitan species, *Artemia salina*, which ranges from Greenland to Australia, and from the Great Salt Lake of Utah to Central Asia.

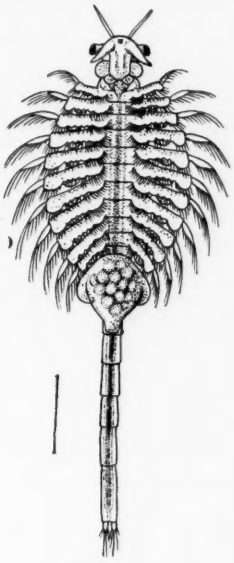


FIGURE 1.
The Brine Shrimp, *Artemia salina*. Female, from below.
The line indicates actual length. (After G. O. Sars).

FIGURE 2.
Nauplius larva, just hatched, highly magnified. (After G. O. Sars).

The Brine Shrimp belongs to the sub-class Branchiopoda, which includes the most primitive of existing Crustacea, and it is closely allied to the "Fairy Shrimp," *Chirocephalus diaphanus*, recently described in the pages of "KNOWLEDGE" (July, 1910), by Mr. G. W. Pyman.

The body of *Artemia* is usually about half-an-inch in length. Like that of *Chirocephalus* it is worm-like and completely divided into segments, without a protecting shield or carapace, such as is found in most other Crustacea. The first eleven segments behind the head each carry a pair of flattened fin-like feet, by the rhythmical movements of which the animal swims. The hinder part of the body forms a slender tail and is without appendages. The head bears a pair of compound eyes set on movable stalks and a third eye, very small and of simple structure, in the middle line in front; the three eyes are coloured with dark reddish-brown pigment. There are two pairs of feelers, the first pair, or antennules, slender and thread-like, the second, or antennae, short and stumpy in the female, but very large in the male, and forming a pair of curiously-shaped claspers for seizing the female. The female, when fully mature, carries her eggs in a sac-like receptacle on the under-side of the body at the base of the tail. The animals are generally of a pale reddish colour, owing, as Sir Ray Lankester first showed, to the presence in the body fluids of haemoglobin, the substance which gives its colour to the blood of Vertebrates but is not often found in Invertebrate animals.

The Brine Shrimp, like most of the Branchiopoda, usually swims back downwards, and it feeds on minute floating organisms and particles of organic matter which are drawn in towards the mouth by the movements of the feet.

The phenomena of reproduction are of particular interest. Like many, but not all, of the Branchiopoda the Brine Shrimp reproduces extensively by parthenogenesis, that is to say, the females lay eggs which are capable of development without being fertilised. In some localities, in fact, it appears that males are never found, the colonies consisting entirely of females. In other localities the two sexes occur in nearly equal numbers, and reproduction takes place by fertilised eggs. There is some evidence to show that there may be two races of Brine Shrimps, the one exclusively parthenogenetic, the other sexual, but it is by no means clearly ascertained what the exact relations between the two forms are.

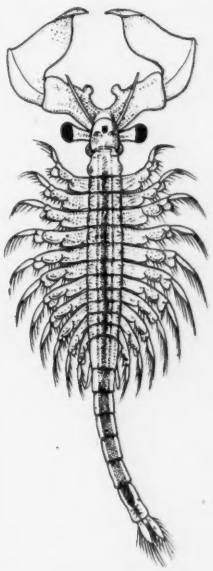


FIGURE 3.
The Brine Shrimp, *Artemia salina*, Male, from above.
(After G. O. Sars).

The eggs are globular in shape, about one-hundredth of an inch in diameter, and when deposited are enclosed in a tough shell which

enables them to survive being dried. In this condition the eggs may be carried long distances in mud, adhering to the feet of wading birds, or may be blown about by the wind, and the distribution of the species from one locality to others is thus rendered possible. Sometimes, however, the Brine Shrimp is viviparous, the eggs hatching while still within the brood-sac, and before the shell has been completely formed. In either case, the young appear first in the form of tiny six-legged larvae with an oval unsegmented body and a single eye. This type of larva, known as a *nauplius*, is found in many other groups of Crustacea, such as Copepods, Barnacles, and some of the true Prawns, which in the adult state are very different from the Brine Shrimp. In the course of development the body elongates and becomes divided into segments, the eleven pairs of swimming feet successively appear, the stalked eyes grow out at the sides of the head, the three pairs of nauplius limbs lose their swimming branches and become the antennules, antennae, and mandibles, and the animal gradually acquires the form and structure of the adult.

The great variability of the Brine Shrimp, already alluded to, seems to be correlated with the varying chemical composition and concentration of the solutions in which it lives. It has been found in water containing no less than 27 per cent. of dissolved salts, while on the other hand it sometimes, though rarely, occurs in water that is quite fresh. In Central Asia, Brine Shrimps have been found living in lakes containing so much sodium carbonate that the water had a distinctly "soapy" feel. A Russian naturalist, Schmankewitsch, showed, many years ago, that it was possible, by breeding *Artemia* in solutions of varying concentration, to produce changes of form, especially in the end-lobes of the tail. Some of the characters thus produced had previously been regarded as distinctive of separate species, but there is no ground for the statement sometimes made that the experiments resulted in changing one species into another. They simply showed that the species had been mistakenly separated on variable and untrustworthy characters. The statement that some of the specimens assumed the characters of the allied but quite distinct genus *Branchipus* has since been shown to be erroneous.

The manufacture of salt from sea-water in the way described above has long since ceased in this country, though it is still carried on on the shores of the Mediterrannean, and it is probably many years since the Brine Shrimp became extinct as a member of the British fauna. An accidental observation recently made at the Natural History Museum shows, however, that it is probably a very simple matter for anyone to obtain a supply of living specimens. A solution of "Tidman's Sea Salt," which had been set aside and forgotten, was found after some weeks to have about a dozen full-grown Brine Shrimps actively swimming about in it. All of these were females and carried egg-pouches full of eggs, which were deposited shortly afterwards and in a few days the larvae of a second generation were hatched from them. A fresh packet of the salt was then experimented with. About eight ounces were dissolved in five pints of tap water, and microscopic examination of the sediment showed that it contained numerous eggs. In about four days a swarm of nauplius larvae issued from these, and in the course of a fortnight they were well on the way to assume the adult form, although still very small.

It is impossible, without further trial, to say whether eggs capable of development are always present in Tidman's Sea Salt. They cannot retain their vitality indefinitely, and, in fact, a very old sample of the salt found among the Museum stores proved to be barren of life. It need hardly be said that salt which in the course of manufacture has been exposed to artificial heat, would contain no living eggs. In reply to an inquiry on this point Messrs. Tidman & Son kindly stated that their Sea Salt is manufactured abroad from sea-water evaporated by the sun's heat.

NOTICE.

THE *SOUTH AFRICAN JOURNAL OF SCIENCE.*—In the April issue of the *South African Journal of Science* appear notes on *Crotalaria Burkeana* and other leguminous plants causing disease in stock. Beasts eating *Crotalaria* develop laminitis within a few days, their hoofs grow long and, unless attended to, the beasts get so stiff in the joints that they lie down and are unable to rise again. Goats seem to be immune and it is curious to note that the same fact is recorded in the case of *Cytisus proliferus* in the Canary Islands. This *Crotalaria* is recorded from the Transvaal, Orange Free State, the Cape Province and Natal and there is one record from Zululand. It is most common on sandy soils and it is found that even if it exists in the unbroken veld in such small quantity as to be harmless, as soon as the land is cultivated and maize or kaffir corn planted, the *Crotalaria* makes its appearance along with them. The plant is said to be most poisonous when the pods, called by the Boers "Klappers," have developed. In the Eastern and Central United States *Crotalaria sagittalis* or "Rattle-box" produces a stock disease called "Crotalism" or "Missouri bottom disease," which is more frequently fatal than that induced by the South African *Burkeana*. Other species of *Crotalaria* in Australia are known to be injurious to stock. The notes also record the effect of *Lessertia*, *Melolobium* and *Cytisus*, in Africa; *Swainsona galegifolia* (Darling pea or indigo) in Australia; *Astragalus*, *Oxytropis* and *Sophora*, in America.

In the same number Dr. P. D. Hahn describes a geyser in Rhodesia, the only one that has been discovered in that country. The geyser is situated near Fulunka's Kraal, about two miles south of the Zambesi River and forty miles below the confluence of the Gwai River. It issues from a round hole, about two inches in diameter, in solid sandstone and throws up a continuous stream of water eight feet high. The temperature of the water is slightly below boiling point; the force with which the water is expelled is not great, as the geyser can be easily plugged with a stick, while a ten pound stone placed over the aperture will stop the play of water. Analysis shows the silica content of the water to be 13·65 grains per gallon. The water of ordinary springs, either deep-seated or surface, rarely contains so much as one grain of silica per gallon, while the Iceland geysers show from eleven to thirty-five grains.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, D.Sc., B.A.

ENCKE'S COMET.—Dr. O. Backlund has recently published some further researches on this comet. The observations of each return since 1891 have been compared with theory. The dates of perihelion (all expressed in Berlin mean time) are:—1895, February 4·785; 1898, May 26·898; 1901, September 15·501; 1905, January 11·916; 1908, April 30·946; 1911, August 19·0656. The mean daily motions at these returns is 1070″ *plus* the following:—3″·934, 4″·157, 3″·625, 5″·084, 5″·848, 5″·668. The other predicted elements for 1911 are:—Node, 334° 29′ 32″; Omega, 184° 39′29″, i, 12° 34′ 32″; e, 0·845723. The most interesting feature of this comet is the acceleration of its mean motion. Dr. Backlund finds evidence that this suddenly changed its amount in 1858, 1868, 1895 (beginning), and perhaps 1904 (end). Several of these dates are near sunspot maximum, and it is suggested that the cause is to be sought in some solar disturbance.

The comet was extremely faint at its last return, in 1908, and was only obtained (by photography) at the Cape Observatory. It is not thought that this means any permanent loss of light, as it had often before been very faint when in a similar position with regard to the Earth. It is brightest at winter returns, of which the next will occur at the end of 1914; at these times it is quite a conspicuous telescopic object, and is sometimes visible to the naked eye. Before its periodicity was known it was independently discovered at three consecutive winter returns—those of 1786, 1795, 1805—which shows that it must have been a fairly conspicuous object. The following is an ephemeris for the present year, for Berlin noon:—

	R.A. H. M. S.	N.Dec.		R.A. H. M. S.	Dec.
July 1 ...	4 16 17	28° 14′	Aug. 6...	8 12 3	23° 55′
„ 5 ...	4 35 26	28° 54′	„ 24...10	44 31	5° 46′N.
„ 9 ...	4 56 15	29° 26′	„ 28...11	16 6	1° 2′N.
„ 13 ...	5 18 50	29° 46′	Sept. 1...11	46 24	3° 28′S.
„ 17 ...	5 43 18	29° 52′	„ 5...12	15 45	7° 41′
„ 21 ...	6 9 40	29° 38′	„ 9...12	44 22	11° 32′
„ 25 ...	6 37 54	29° 1′	„ 13...13	12 17	14° 59′
„ 29 ...	7 7 52	27° 54′	„ 17...13	39 27	18° 2′
Aug. 2 ...	7 39 20	26° 14′	„ 21...14	5 44	20° 38′S.

If seen at all in Europe it will be in July. It will then be about one hundred and fifty million miles from the Earth.

HALLEY'S COMET.—This is still being diligently followed at the Yerkes Observatory. *Popular Astronomy* for May contains a reproduction of a photograph taken by Mr. F. Slocum with the two foot reflector, with one hour's exposure. The comet appears quite distinctly as a short trail. It was then one hundred and ten million miles further from the sun than on September 11th, 1909, and yet very much brighter, showing that the physical brightening at perihelion persists for a long time. It will be followed at least up to conjunction with the sun, and possibly recovered in the autumn after that. Professor Barnard writes that he got good measures on April 16th, 23rd and 25th; an observation on May 2nd was doubtful owing to moonlight. The comet was of magnitude 15 in April, but is rapidly getting fainter; its diameter is about 10″. On April 23rd at $14^h\ 45^m\ 48^s$ Greenwich mean time, its right ascension was $9^h\ 53^m\ 27^s{\cdot}28$, South declination 7° 48′ 23″·9. This was more than a year after perihelion passage.

A query that appeared in "Knowledge" for April, page 135, asks how the distance of this comet from the sun and its speed can be calculated at any time. There are probably a sufficient number interested in this problem to justify its discussion here. I deal with it only on the assumption of elliptical motion, as the discussion of perturbations would need too much space. t denotes the interval in days since the perihelion passage of 1910, April 19·68. u is an auxiliary angle known as the "eccentric anomaly." We must find u by trial from the equation

$$t \times 0^\circ{\cdot}012967 = u^\circ - 55^\circ{\cdot}4216 \sin u$$

For example put $t = 731$ days, which brings us to 1912, April 19·68. The left hand side $= 9^\circ{\cdot}478$. Trying in succession 40°, 50°, 57° for u, the right hand side becomes 4°·37, 7°·54, 10°·52. Interpolating and making a few more trials we obtain the correct value of u, viz., 54°·721.

Next we find r, the distance from the Sun, by the equation

$$r = 17{\cdot}945\ (1 - 0{\cdot}96729 \cos u).$$

Substituting 54°·721 for u, this becomes 7·9197, the unit being the Earth's distance from the Sun. To bring to miles we multiply by 92,820,000.

The velocity expressed in units of the Earth's mean velocity is

$$\sqrt{\frac{2}{r} - \cdot 055726}.$$

To reduce it to miles per second we multiply by 18·47.

In the present case we get $18{\cdot}47\ \sqrt{\cdot 252534 - \cdot 055726}$

log. 18·47 = 1·2665
log. ·196808 = 9·29404
half this = 9·64702
log. miles per second = 0·9135
Miles per second = 8·194.

MASSES OF STARS.—Professor Lowell has an article in *Popular Astronomy* for May, on the masses of binary stars. Grouping the results according to parallax, he finds the resulting mass steadily increases with the distance. This is discussed, and shown to indicate the unreliability of the smaller parallaxes, $\frac{1}{15}$ of a second being determined as the smallest that can be trusted. The following are the final figures:

Limits of parallax.	Mass of binary (Sun=1).
Above 0″·4	1·93
0″·2 to 0″·4	1·77
0·1 to 0·2	1·33
0·067 to 0·1	1·43
0·033 to 0·067	1·95
0·017 to 0·033	3·46
0·007 to 0·017	33·43

This shows that for the best determined parallaxes the mass of each component is very near that of the Sun. We have good reason for thinking that there are stars (such as Aldebaran and Arcturus) whose mass vastly exceeds the Sun's, but these are probably exceptional. Professor Lowell altogether discusses twenty-six pairs, and his result tends to the conclusion that the masses of the stars vary much less widely than their lustre.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

FORMALDEHYDE AS FOOD FOR GREEN PLANTS.—It has long been known that the first product in the making of organic food by green plants, from the carbon dioxide and water absorbed by their leaves and roots respectively, is formaldehyde (CH_2O), the starting-point for the formation of carbohydrates and of higher compounds. Various experimenters have endeavoured to show that plants can utilise formaldehyde as food material when presented to them, in

XUM

the absence of a supply of carbon dioxide, but success has only been obtained with simple freshwater Algae like *Spirogyra*. Twenty years ago, Bokorny showed that though formaldehyde is poisonous, even in very dilute solutions, yet a substance called oxymethyl sodium sulphonate (easily broken up into formaldehyde and sodium sulphite) can be used in culture solutions, in the proportion of 1 per cent., without injury to *Spirogyra*.

Grafe (*Ber. d. deutsch. bot. Ges.*, 1911) has now experimented with the French Bean, and finds that seedlings of this plant can make use of the vapour of formaldehyde. He allowed the seedlings to germinate, removed their cotyledons (containing reserve food), and placed them in vessels exposed to light. In some cases, the seedlings were supplied with air deprived of carbon dioxide, but containing formaldehyde vapour. The results showed that the plants made use of the formaldehyde vapour, producing abundant sugar in their leaves, and increased greatly in dry weight, as compared with the control or comparison plants not supplied with formaldehyde. Apparently, however, the formaldehyde prevented the formation of starch from the sugar.

A NEW FUNGUS IN THE BEET ROOT.—In the course of his work on the disease of Sugar Beet caused by Nematodes (round-worms), Nemec found a Fungus, belonging to the Chytridiaceae, in the cortex of the lateral roots. He has now (*Ber. d. deutsch. bot. Ges., 1911*), given an account of the structure and life history of this Fungus—a new genus and species called *Sorolpidium Betae*. It belongs to the Chytridium family, and therefore to the lowest forms of Fungi. It appears in the cortex cells as a nucleated mass of protoplasm, which grows larger at the expense of the cell and finally nearly fills it. Then the Fungus cell acquires a cell-wall, and its contents divide into several uni-nucleate portions or sporangia. Each sporangium then produces two, three, or four zoöspores, which escape, swim about, and infect other cells. In several respects, Sorolpidium resembles the Plasmodiophoraceae—the group to which belongs the Fungus causing finger-and-toe disease of the turnip. Nemec considers it as a link between this group and the Chytridiaceae, and as indicating the close relationship of the two groups.

LIFE HISTORY OF ZANARDINIA.—The genera *Cutleria* and *Zanardinia*, forming the small family Cutleriaceae, are of great interest, because they form a transition from the lower Brown Algae, in which the sexual cells, if formed, are nearly or quite alike in size, to the higher Brown Algae (*Dictyota* and *Fucus* series) in which the female cell is an oösphere, much larger than the male cell, and differing from it in not being motile.

The life history of *Cutleria* has already been worked out in some detail by various botanists, including Falkenberg, Sauvageau and Church. The sexual and asexual plants are very different, the former being an erect ribbon-like and much-divided structure, while the latter is a flat creeping disc of roughly circular outline. Before the connection between the two forms was discovered, the asexual form was called *Aglaozonia*, and was regarded as an entirely different plant. Careful investigation has shown that *Cutleria* may be regarded as consisting potentially of a basal disc, producing spores, and an erect branching portion producing sexual cells. The two portions require quite different conditions in order to develop fully. In the Mediterranean, the *Aglaozonia* form occurs in summer, and the *Cutleria* form in winter. In England the reverse holds good. In the north, the *Cutleria* form becomes more and more scarce, and the plant is represented by only the *Aglaozonia* form on the Scandinavian coast. Conversely, in the south the *Aglaozonia* form becomes rarer, and at Naples it is unknown, only the *Cutleria* form being found there.

The life history of *Cutleria* is a good illustration of the influence of external conditions on the course of development of the reproductive cells. Normally, the fertilised *Cutleria* egg produces an *Aglaozonia* plant, but this stage may be omitted, and a *Cutleria* plant arise directly. The zoöspores produced by the *Aglaozonia* normally produce a *Cutleria* plant, and this usually produces *Aglaozonia* discs from its base; the *Cutleria* plant may undergo arrest of growth, leaving the *Aglaozonia* to continue the life history. Northern conditions favour the predominance of the asexual or *Aglaozonia* form, while southern conditions favour that of the sexual or *Cutleria* form.

Yamanouchi (*Bot. Magazine*, Tokyo, 1911) has worked out the development of *Zanardinia*, which is allied to *Cutleria*, but has a disc-like thallus only. The nuclear divisions of the ordinary cells of the disc-like asexual plant show forty-four chromosomes; the division of a zoöspore mother-cell shows reduction, so that the zoöspore has twenty-two chromosomes. The zoöspore produces a disc-like sexual plant with twenty-two chromosomes in the nuclei of its cells; the fertilised egg cell has forty-four chromosomes, and this number is present in the asexual thallus to which it gives rise.

In *Zanardinia*, therefore, there is a regular alternation of generations, exactly as in *Dictyota*, *Polysiphonia* and so on, characterised by (1) different number of chromosomes in the sexual and the asexual plants (2) one plant being asexual and the other sexual. The asexual and sexual plants are exactly similar in structure, apart from the difference in the nuclei, just as is the case in *Dictyota* and *Polysiphonia*.

MAIZE SUGAR.—Doby (*Chem. Zeitung*, 1910, page 1330) has investigated the different forms of Maize which are grown in Europe, with a view to their productiveness in the manufacture of sugar, cellulose and alcohol. Owing to its intolerance of frost, or even of cold nights, Maize is hardly grown in England, except as green fodder, its stems being sweet, owing to the presence of cane sugar. Even in the warmer parts of Germany the amount of sugar in Maize is not so high as in America, but the culture of Maize nevertheless pays well. The largest amount of sugar is obtained on removing the young cob before the seeds have been allowed to ripen. When the cob is removed the amount of sugar passing up the stem increases until it reaches a maximum, when it diminishes again owing to respiration taking place in the still growing stem. The stems, leaves, and even the axis of the cob, afford excellent material for the manufacture of paper; the unripe cobs, as well as the green stems, can be used in the manufacture of alcohol.

THE NUCLEOPROTEINS.—A large amount of work has been done in recent years, on the nucleoproteins of both plants and animals. Much of this has been collected by Brugsch and Schittenhelm in their text-book, "Die Nucleinstoffwechsel und seine Störungen" (1910). Plimmer (*Journal Chem. Soc.*, vols. 93, 94) has indicated accurate methods for the determination of the nucleoproteins according to the quantity of phosphoric acid and the purin bases, which are the results of the splitting of the nucleoproteins by hydrolysis.

The nucleoproteins differ from other proteins in consisting of a protein combined with nucleic acid, the latter containing phosphorus, and in their resistance to the action of enzymes which readily decompose the primary proteins into peptones and simpler nitrogenous substances. Being essential constituents of the nuclei of plants and animals, they play an important part in the physiology of the cell, for the existence and development of which they are essential. The embryonic and glandular cells of animals are rich in nuclear material, and contain relatively large quantities of nucleoproteins. The same is the case with the embryonic cells of plants, not only in embryos, but also in the embryonic tissues and growing points of the stem. It is clear that formation of nucleoprotein material must take place during growth of the active tissues of plants, since increase in amount of nuclear material precedes the division of the nucleus.

Zaleski (*Ber. d. deutsch. bot. Ges.*, 1911) has investigated, by analysis, the changes in amount of nucleoproteins during growth of certain plants, *e.g.*, bean stems, leaves, roots, onion bulbs, seedlings. His results indicate that during growth

there is a steady increase in the amount of nucleoprotein present in the plant. He deprecates the attempt made by some writers to attribute to the nucleoproteins the qualities of "life-bearers," "inheritance-bearers," and so on, and points out that protoplasm is an exceedingly complex structure, made up of many protein substances, though its complete chemical structure is quite unknown.

FURZE THORNS.—In 1893, Lothelier described experiments on the influence of humidity and light on the development of the leaves and branches of various spiny plants (Furze, Barberry, and so on). He claimed that branches of Furze, which under normal conditions are developed as thorns, tend to lose their spiny character and to produce leafy branches. The results obtained by Lothelier were criticised later by Goebel, who contended that the leafy shoots obtained by Lothelier were simply "reversionary shoots," which can be produced at any time from ordinary Furze branches when the plant is pruned. Zeidler (*Flora*, 1911) has made a series of careful experiments with Furze plants raised from seed, and his results may be thus summarised. (1) Spine formation is hindered in moist atmosphere, also in feeble light—in total darkness seedlings as well as older plants of Furze very quickly perish. (2) Typical more or less flattened foliage-leaves, without spines, are formed on the basal portions of the shoots, when plants are grown in damp air, but these are only formed at the beginning of each season's growth, and, moreover, they may occur on plants grown under normal conditions, so that each year's growth can easily be recognised on a plant. (3) Lothelier's results were due to the fact that he did not use entire plants, but cut portions, and besides he made no control experiments which would have shown that leafy shoots may arise in cut Furze stems grown under normal conditions.

FUNGUS IN LIVERWORTS.—Garjeanne, who has already contributed greatly to our knowledge of the biology of the "fungus servant" or mycorhiza present in various Liverworts, has recently (*Flora*, 1911) made an extensive re-investigation of the subject. He shows that the infection of the rhizoids ("root-hairs") of leafy Liverworts is a widely-spread phenomenon, that different kinds of Fungi may enter into partnership with the Liverworts in this way, that some of these Fungi belong to the genus *Mucor* (to which belongs the common Black Mould found on bread, and so on). In most cases, the particular Fungus, on being isolated and cultivated, proved to be *Mucor rhizophilus*, a new species, with small gonidangia on a slightly-branched gonidiophore. It has a greatly developed mycelium, with numerous transverse walls, and produces several additional forms of spore besides the gonidia.

THE EVOLUTION OF THE FLOWER.—H. F. Wernham has commenced to publish, in the *New Phytologist* (Vol. 10, No. 3, March, 1911), what promises to be one of the most interesting of the various series of papers which have appeared from time to time—in addition to the valuable original memoirs and summaries of recent botanical research—in this the youngest of British botanical journals, which has already taken its place among the leading scientific periodicals of the day. The author concludes his introductory article with the following summary. (1) The fundamental guiding principles in the progressive evolutionary history of the Dicotyledonous flower are two in number, namely (i) economy in production of the several items comprising reproductive organs; (ii) progressive adaptation to the reception of insect visitors. (2) The second of these principles compensates the first for the decreased chance of pollination which the latter involves. (3) There are also certain tendencies which subserve these two main principles, the most widespread being (i) progressively increasing conspicuousness attained either (*a*) by enlargement of the individual flower or, as is by far the more general case (*b*) by excessive branching of the floral axes to produce aggregation of the flowers into dense inflorescences; (ii) devices of floral structure or habit which have obvious relation to insect visits, the chief of these being zygomorphy, which may occur either in solitary or loosely aggregated flowers, but is illustrated more generally by the outer florets of a close inflorescence; (iii) fusion of parts, more particularly to form tubes, the most important type of fusion being sympetaly—the formation of a gamopetalous corolla. (4) The "primitive flower" or prototype will be, of course, one in which the working of these principles is realised the least. There will be economy in production; the parts will be, therefore, produced in indefinite numbers, and there will be no great specialisation for the reception of insect visitors—no aggregation, chorisis, zygomorphy, or fusion of parts. An analogy to such a prototype is not wanting in the Gymnosperms, for we find it in certain members of the Bennettitales, and reflected in the typical flowers of certain Ranalian orders, *e.g.*, the Magnoliaceae.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

MUTTON BIRD OIL.—Numerous sea birds, including the petrels and fulmars, contain a very high proportion of oil, and for this reason are greatly valued by the natives upon the Scottish Coasts, who obtain from them "oil for their lamps, down for their beds, a delicacy for their table, a balm for their wounds, and a medicine for their distemper." In the Island of St. Kilda it is only legal to kill the fulmars during one week in the year, but during that week from eighteen thousand to twenty thousand birds are destroyed. So rich in oil are these birds, that by passing a wick through their bodies they may be used as lamps.

Hitherto the nature of the oil in these birds has not been investigated, but in a recent issue of the *Journ. Soc. Chem. Ind.* (1911, XXX, 405), there is an interesting account by Mr. Hewgill Smith of the characteristics of the oil of the Antarctic petrel, the mutton bird (*Aestralata lessoni*), which during the breeding season, is slaughtered in large quantities upon the coasts of Tasmania and New Zealand. The "oil" of this bird, which has now become a commercial product, is carried in the stomach, whence it can be ejected through the nostrils as a means of defence against its enemies.

This oil, which is found in the stomach of the dead bird, is a pale yellow or bright red liquid with a faint fishy odour. When cooled to 0° C. it solidifies to a transparent mass. The specimen examined by Mr. Smith had a specific gravity of 0·8819 to 0·8858 at 15° C. and absorbed 71 per cent. of iodine. It contained a high proportion (36·9 per cent.) of unsaponifiable alcohols, and, unlike the majority of animal fats and oils, contained no glycerine. In its general composition and properties it closely resembled Arctic sperm oil and, like that oil, did not thicken when exposed to the air. It would thus be useful as a lubricant, if it could be obtained in sufficient quantity, which is, however, unlikely. The body fat of the bird was of quite a different character from this oil, being a soft brownish solid with a specific gravity of 0·9351 to 0·9380, an iodine absorption value of 89·1, and containing only 1·76 to 2 per cent. of unsaponifiable matter. This appeared to be an ordinary fat, whereas the "oil" might be classed with sperm oil among the liquid waxes. It has been suggested that the mutton bird uses the oil for feeding its young.

THE DETECTION OF COCAINE.—A test for cocaine has been based upon the fact that it combines with potassium permanganate to form pink crystals in the form of nearly square plates. This test has been studied by Mr. E. H. Hankin (*Analyst*, 1911, XXXVI. 1), who renders it much more sensitive by allowing a strong solution of permanganate to evaporate on a glass slide, and then adding a drop of a solution of alum containing the cocaine, and watching the crystallisation under the microscope. The use of the alum is to retard the action of the permanganate, and in this way it is possible to distinguish between cocaine and certain other allied anæsthetic compounds. As an illustration of the delicacy of the test, Mr. Hankin cites an instance where a man suspected of illicit dealing in cocaine had received timely warning of the visit of the police. No cocaine was found, but various pieces of paper, in which it was supposed that the drug had been wrapped were subjected to the permanganate test, and in the case of ten out of eleven pieces the characteristic cocaine crystals were seen to develop. In another case a

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stain upon a telegraph form, which was supposed to have been produced by the saliva of a person who had taken cocaine was examined in the same way, and here, too, an unmistakable reaction was obtained.

ACTION OF STEAM UPON CARBON AND LIME.—The possible mode of formation of marsh gas and other natural gases rich in methane is suggested by the results of experiments made by M. L. Vignon (*Comptes Rendus*, 1911, CLII, 871) upon the action of steam upon a mixture of carbon and lime. It was found that the steam was decomposed more rapidly and at a lower temperature by a mixture of carbonaceous substances and lime than by the carbon alone. Thus when the steam was conducted through the mixture contained in a porcelain tube heated to about 600° to 800° C. the resulting gas was found to contain hydrogen, methane, carbon monoxide, oxygen, and nitrogen, the proportions depending upon various factors such as the quantity of steam present, and the duration of contact between the excess of steam and the methane formed, more or less decomposition taking place in accordance with the equation—

$$CH_4 + H_2O = CO + 3H_2$$

Thus twenty-eight per cent. of methane was produced by the passage of five grammes of steam during thirty-five minutes, whereas only about eight per cent. was obtained after the passage of fifteen grammes of steam during two hours. By regenerating the lime from the calcium carbonate produced it was found possible to transform the whole of the organic substances present into hydrocarbons in the following manner

$$2C + CaO + 2H_2O = CaCO_3 + CH_4$$

and

$$CaCO_3 = CaO + CO_2$$

or combining the two equations—

$$2C + 2H_2O = CO_2 + CH_4$$

Since the methane requires a lower temperature for its formation than that of the decomposition of the calcium carbonate, the two gases may be collected separately.

It is suggested that these experiments also throw light upon the formation of petroleum deposits. When animal and vegetable remains are left in contact with water in the presence of calcareous deposits, hydrocarbons are produced, and it is quite possible that these, under the influence of various physical conditions of pressure, and so on, have been transformed into petroleum compounds.

GEOLOGY.

By RUSSELL F. GWINNELL, B.Sc., A.R.C.S., F.G.S.

CARBON IN GOLD ORE.—The well-known auriferous conglomerates of the Witwatersrand, known as "banket," consist of beds of coarse well-rolled quartz pebbles, together with smaller pebbles, the whole being cemented into a compact rock by means of secondary silica. They are obviously shore deposits, and are of very great—perhaps pre-Cambrian-age. The gold occurs in the matrix and not in the pebbles themselves. Pyrites is commonly present, and also in places, carbonaceous or graphitic matter. As the origin of the gold appears to be intimately related to that of the other "impurities," it is a matter of considerable interest to determine the source of the carbon. This latter has been regarded as organic matter which directly precipitated the gold from solution, although this seems hardly likely in face of the fact that there is neither gold nor carbon in the finer sediments which are associated with the banket. For a fine sediment is naturally expected to yield organic matter in greater abundance than does a coarse conglomerate. Writing in the *Transactions of the Geological Society of South Africa* (Vol. XIII., 1910), on "The Mode of Occurrence and Genesis of the Carbon in the Rand Bankets," Mr. C. Baring Horwood shows that from its mode of occurrence the carbon is of later date than the bankets, and is of inorganic origin. Gold can be found not only as a film on the particles of carbon, but also actually embedded in the latter. The carbon occurs frequently in small irregular spheroids sometimes actually replacing the quartz, and it is almost invariably closely associated with pyrites when the latter is present. Furthermore, it occurs chiefly along and on both faces of partings in the banket and along planes oblique to the bedding. These facts cannot well be accounted for by any theory of organic origin. Indeed the mode of occurrence of the carbon strongly recalls the crystals of tourmaline of pneumatolytic origin, found on the surface of joint planes in the red granite of the Bushveld. The author's researches lead to the conclusion that the carbon is of deep-seated origin and owes its presence in the bankets to associated igneous magma, probably through the agency of pneumatolysis. Other authors have ascribed an inorganic origin to certain petroleums, and have included both graphite and diamond as the end products of the petroleum series. Now, great diabase dykes penetrate the Rand country, and to these one would naturally look for the source of the carbon (and incidentally of the gold). Analyses shew that carbon is distributed evenly throughout the igneous rock, which would hardly be the case if it were derived from organic fragments caught up and enclosed in the molten magma at the time of its intrusion. The fact that gold is not found, as is the carbon, distributed about equally in dyke-rock and in banket is easily accounted for by its relatively greater solubility. On this account, subsequent leaching-out of the gold has removed it from the dyke-rock. Summarily, the study of the carbon in those mines of the Rand where it is most typically developed certainly shows that its occurrence is closely associated with that of the pyrites and gold, and indicates a close relationship between its presence and that of neighbouring igneous rocks which contain carbon. The occurrence of the carbon in tiny spheroids scattered through the matrix of the bankets points to deposition from gaseous or very mobile liquid hydrocarbons, before the final cementation and induration of the bankets by the deposition of secondary silica. Taken in conjunction with the known facts of its occurrence in other parts of the world, it is reasonable to attribute its origin to magmatic vapours or solutions derived from the neighbouring basic igneous intrusions before their final consolidation.

LABRADOR, A LAND OF PROMISE.—In the *Geographical Journal* for April, Dr. Wilfred T. Grenfell sings the praises of Labrador after an acquaintance with it of twenty years. The country has been greatly neglected up to the present time and little knowledge exists of its resources beyond its coastal portion. Yet the author is confident that Labrador can and will carry, in the days to come, a population as easily as Norway does to-day. It is a better country by far than Iceland, and until the wizard hand of man was turned to New Mexico, Arizona or even to parts of Egypt and West Australia it was able to offer as good attractions to settlement as any of them. "If ever a race shall rise to people her glorious fjords and inlets, and to wrest her undoubted wealth from her forests and mines, she will, like all northern countries, evolve a people endowed with those sterling physical qualities that characterised the Vikings of old." The agricultural outlook of Labrador is not hopeful owing to the fact that the super-incumbent rocks have been removed by glaciation from the Archaean floor, which is thus laid bare over much of the country. On the other hand this fact need not injure the prospects of the development of mineral resources. While very little serious geological work has been done, the deductions of the few prospectors who have visited the country show every possibility of valuable mineral deposits. The inland resources are almost unknown, but near the coast several deposits of economic value have been found, and in some cases worked; among these are alluvial gold, antimony, mica, copper, iron pyrites and garnet. Coal which may be a continuation of the seams of Cape Breton, has been partially prospected. Finally, the beautiful plagioclase felspar Labradorite, which derives its name from the country and which exhibits an iridescent play of colours, has been worked in an island near Nain, which consists almost entirely of this mineral.

AN IGNEOUS COMPLEX AND ITS ORIGIN.—A number of instances are now known of igneous rock-masses

within which are found a series of different rock-types arranged in a concentric manner. In some of these cases, on the ground of field evidence, the occurrence has been considered as a laccolith within which *subsequent differentiation* has produced the concentric complex; in others they have been held to be stocks, or volcanic necks, in which differentiation has occurred, sometimes with subsequent movement of the differentiated bodies of magma. In the *American Journal of Science* for April, L. V. Pirsson and W. North Rice describe a case which appears to be a laccolith, intruded between a granitic bathylith and a cover of mica schist. This is Tripyramid Mountain in New Hampshire, a roughly oval mass, rising about two thousand feet above the floor of the neighbouring valleys. Around an inner core of *syenite* occurs a medium grained *monzonite* which is succeeded below and outwardly by coarse-grained *gabbro*. Lamprophyre dykes (regarded as complementary to the syenite-aplite) are situated in the peripheral gabbro and in the granite against which the complex abuts. All the rock-types in the complex possess a parting or sheet-jointing parallel to a dome-surface, but there is a sharp transition-line between the different types and only slight endomorphic evidence of contact. As to the mode of origin of the complex, the authors do not consider the case as similar to that of Magnet Cove, Arkansas, which Harker has explained as being due to the doming and erosion of superposed sheets, successively injected. The common jointing is not in favour of this, nor the relative textures of the rock types, for this view would make the gabbro, which is the coarsest grained variety, the uppermost sheet. The suggestion that zonal arrangement of different rock-types in an intrusion may be due to absorption and assimilation of surrounding country-rock is equally inapplicable in the present case. For while the country rocks (granite and mica schist) are decidedly acid in character, the border facies of the complex is the basic gabbro, the intrusion becoming more acid towards the centre.

While the concentric arrangement of the complex naturally suggests a differentiation of a body of magma in place, the abrupt transition of one type into another, and the occurrence of syenite dykes in the monzonite, and probably of monzonite dykes in the gabbro, negative this conclusion, the dykes suggesting a series of successive intrusions. Apparently what best explains the phenomena at Tripyramid Mountain is a process of intermediate nature, in which both differentiation and repeated intrusions, separated by only short intervals, took place.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE Weekly Weather Reports issued by the Meteorological Office show that during the week ended April 22nd the air temperature was in excess of the average in all districts, by as much as 4°·9 in England, N.E. and E. The extreme maxima varied from 59° in Scotland N. (at Strathpeffer) to 69° in England E. (at Cambridge), while the minimum fell to 27° at West Linton and to 28° in the Shetlands and at Wick. Even as far South as Swarraton in Hampshire a temperature of 30° was reported. In the English Channel the lowest reading was 40°. On the ground much lower temperatures were, as usual, experienced, and at Crathes the reading was as low as 20°, at Balmoral 23°.

Rainfall was in defect in the East and South of England, but elsewhere was in excess. In Scotland N. the amount collected was three times as much as usual, and in Ireland it was twice as much. In England E. and S.E., however, the fall was very slight and at many stations the week was rainless. As a rule sunshine was less than usual. The sunniest places were Felixstowe (60·6 hours, 63%) and Guernsey (61·9 hours, 65%), while Valencia had only 5·7 hours (6%). At Westminster the total duration of sunshine was 39·7 hours (41%).

The mean temperature of the sea water round the coasts varied from 49°·9 at Seafield to 40°·2 at Cromarty.

The week ended April 29th, was warm but cloudy and unsettled, with thunderstorms and hail. The temperature was above the average in all districts, the greatest excess being in England E., where it was 4°·6 higher than usual. The highest maximum, however, was 2° lower than that of the previous week, being 67° (at Cirencester) on the 23rd, as against 69° (at Cambridge) on the 22nd. The lowest readings were 28° at Balmoral and 30° at Nairn, but at no other stations in the United Kingdom did the air temperature fall below the freezing point. On the ground the temperature fell to 23° at Crathes, and to 25° at Balmoral.

Rainfall was in excess in all parts. At several stations rain was measured on every day. At Donaghadee, on the 29th, there was a heavy thunderstorm with rain and hail, the total precipitation for the day being 1·12 inches.

Sunshine was everywhere deficient, and in some places less than half the usual amount was recorded. Torquay reported the largest aggregate, 48·5 hours (49%). At Westminster the total was 35·3 hours (35%).

The mean temperature of the sea water ranged from 40°·7 at Cromarty to 50°·8 at Seafield.

The week ended May 6th was unsettled at first but the weather improved later.

Temperature was low in most places, although the defect was nowhere very great. The highest reading reported was 66° at Alnwick Castle and at Raunds. Frost was experienced in several places, the lowest readings being 28° at West Linton, and 29° at Fort Augustus. The grass thermometer went down to 23° at Crathes, and to 24° at Burnley.

Rainfall was again in excess, except in England N.E. and E., where it was slightly in defect, and in the Midlands, where it was almost normal. In Scotland and in Ireland the rainfall was very heavy, and at Fort William the total for the week was as much as 3·27 inches, and at Killarney 2·34 inches.

Sunshine was above the average in England E. and S.E., and in the Midlands, though below it elsewhere, except in Scotland N., where, in spite of the fact that the rainfall was nearly twice as much as usual, the sunshine was 5 hours (5%) in excess of the normal. Brighton reported the longest duration of sunshine, 58·4 hours (57%); at Westminster, the amount was 46·5 hours (45%).

The temperature of the sea water varied from 43° at Pennan Bay and Burnmouth to 54° at Seafield.

The week ended May 13th was fine at first, but became changeable and thundery. Temperature was high throughout, being in excess of the average in all districts. In Scotland W. it was 6°·2 above the normal. Maxima above 70° were recorded in all parts, the highest being 76° at Colmonell and Greenwich. No frost was experienced, the lowest of the minima being 33°, which was reported from Geldeston Bawtrey and Marlborough. The lowest temperatures on the grass were 27° at Kew and at Rauceby, and 28° at Greenwich, Tunbridge Wells and Wisley.

Rainfall varied a good deal in different parts of the country. It was a little above the average in Scotland, and in Ireland N., but was below elsewhere, and in some places very greatly below. In the Midlands it was only one-third, and in the English Channel, less than one-seventh of the usual amount. Some heavy falls were however experienced, especially during the thunderstorm on the 13th, when the rain collected at York and at Rothamsted measured 1·2 inches, at Killarney 1·4 inches, and at Newton Rigg and Burnley 1·7 inches.

Sunshine was generally above the average. England S.E. was the sunniest district, with 68 hours (65%), or 21 hours above the normal. Of the individual stations, Felixstowe reported the largest aggregate 89·7 hours (85%), and Hastings the next largest, 82·7 hours (79%). At Harrogate the total duration was only 32·1 hours (30%). At Westminster the total was 52·6 hours (50%).

The temperature of the sea water was higher on all coasts than during the corresponding week of 1910. The individual readings varied from 44° at Burnmouth, to 60° at Seafield.

A balloon carrying a Meteorograph was liberated at Manchester at 5.50 p.m. on March 1st and was found at Little Downham, near Littleport, Cambridgeshire, having travelled one hundred and twenty-four miles in a south-easterly direction

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The instrumental record showed that the balloon had reached an altitude of 19·1 kilometres or sixty-two thousand feet. The lowest temperature recorded was 214°·5 (absolute scale) at a height of thirty-three thousand feet. The temperature then increased to 224°·5 at thirty-nine thousand feet, but fell again to 218°·0 at the maximum height.

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD. ARTHUR EARLAND, F.R.M.S.
THE REV. E. W. BOWELL, M.A. RICHARD T. LEWIS, F.R.M.S.
JAMES BURTON. CHAS. F. ROUSSELET, F.R.M.S.
CHARLES H. CAFFYN. D. J. SCOURFIELD, F.Z.S., F.R.M.S.
C. D. SOAR, F.R.M.S.

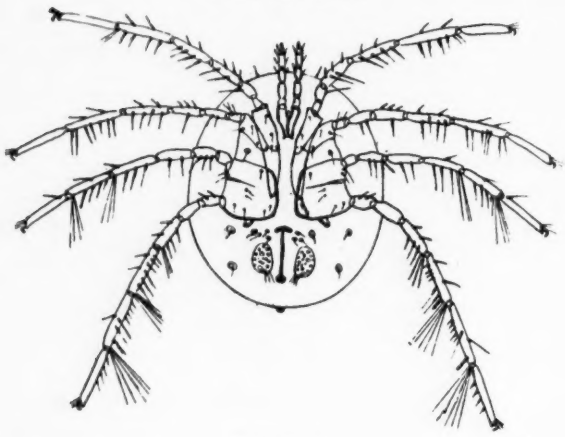

FIGURE 1.

Neumania triangularis, Female, ventral surface.

NOTE ON A WATER-MITE NEW TO BRITAIN (*NEUMANIA TRIANGULARIS* PIERSIG).—In 1908 both sexes of the above mite were taken from a fresh-water pool in the locality of Stourbridge, Worcestershire.

The female is 1·42 millimetres long, of a pale yellow colour. Epimeral plates are finely granulated, the fourth pair having a well-marked hook-shaped process at their lower extremity. The genital plates are green in colour, with thirty to thirty-five acetabula on each. Above each plate are three small hair pores arranged somewhat like the apices of a triangle in outline, together with a prominent gland. Legs are yellowish-green in colour and all supplied with strong spines or swimming hairs, the second and fourth pairs having in addition a number of feathered or serrated hairs presenting a pretty effect under dark ground illumination.

The male is smaller than the female, 1·12 millimetres long, of a light almost transparent yellow colour. The Malpighian vessel is very distinct. Genital plates are circular in outline, of a pale green colour, with about twenty-five acetabula on each half and several fine hairs at top and bottom. Two prominent glands on each side of median line, one towards margin of body. Several species of this genus are described by Mr. C. D. Soar in *Science Gossip*, Vol. VII, p. 19 under the generic name *Cochleophorus*.

G. P. DEELEY.

ON THE IDENTITY OF *HABROTROCHA BIDENS* (GOSSE).—If the recognition of this handsome and graceful Bdelloid depended solely upon the original description ("Catalogue of Rotifera found in Britain," P. H. Gosse, *Ann. and Mag. Nat. Hist.*, 1851), it could only be regarded as hopeless, for the few characters then stated have proved to be common to many distinct forms. Fortunately, however, Gosse found opportunity in "The Rotifera" (Hudson and Gosse, 1886), to provide a fuller description accompanied by figures which, if wanting in detail, give a fair idea of the general style of an animal which seems to be somewhat of a rarity. In about twenty years' experience I have only met with it on two occasions, viz.: in ground moss kindly collected for me by Mr. D. J. Scourfield near Bury St. Edmunds, and from roof moss which I obtained from an accessible roof-gutter near Mundesley.

But before finding, in 1908, the particular form which I am confident is that seen by Gosse, I had repeatedly compared with his description other two-toothed blind Philodinidae, always with unsatisfactory result. That others may avoid the like tedious proceeding, it may be useful to point out the more distinctive details supplied by Gosse, and to give some additional characteristics which will further establish a very interesting species.

The corona and the body outline of my specimens were generally in agreement with Gosse's figures, and they also possessed the wild manners, the small two-toothed rami, and (occasionally) the angular lateral prominence which he described. But the most unusual detail, and, therefore, the best for purposes of identification, was the constantly recurring display of the central toe, short and acute, between the spurs, as shown by Gosse in his figure of the imperfectly retracted position, a pose of the toe and spurs characteristic also of *Habrotrocha tripus* (Murray), but elsewhere unknown among blind three-toed Philodinidae. Gosse describes the foot as having a small stiff point behind and two soft

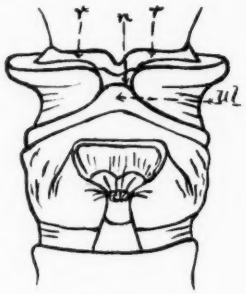

FIGURE 1.

Head with corona (dorsal view).

FIGURE 2.

Extremity of foot (ventral view).

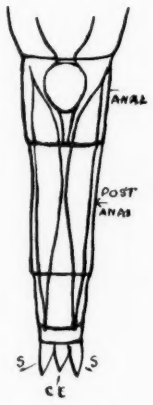

FIGURE 3.

Anal segment and foot (dorsal view).

cylindrical lateral protrusible toes, truncate at the extremities. I do not seem to have seen the truncate ends of the lateral toes, but the central toe was frequently visible as a small stiff point behind.

Gosse's description of the stomach is also noteworthy. In one of his specimens it appeared to be composed of a number of spherical cells, but in others was of a minutely granular texture. These varying appearances of the stomach are quite usual with several species of the "pellet-making" Philodinidae and depend upon the quantity of digestive fluid between the two membranes of the stomach wall. When the fluid is scanty the food-pellets within the stomach cavity are plainly visible, and have the appearance of spherical cells. When the fluid is abundant, its finely-granular consistence is sufficiently opaque to completely hide the actual contents of the stomach. I believe, therefore, that Gosse's description of the stomach indicates that his species was a pellet-maker and in this respect also my specimens agreed with his. *Habrotrocha*

bidens is, in fact, the largest pellet-making species yet found, my examples attaining a length of 460 μ, when apparently fully grown. But apart from its great size, it may be recognised by the slenderness of the anal segment, and by the length of the foot, the post-anal segment being about twice as long as its average width, and also by a peculiar ridge-like structure crossing the trochal discs. When feeding the foot was generally extended, sometimes showing the central toe (*c.t.* Figures 2 and 3), sometimes not. The rather short spurs (*s.s.*) were held nearly parallel to the body axis. The lateral toes (*l.t.*) were invaginated as usual.

A diagrammatic view of the head with corona displayed is given in Figure 1, the cilia of both principal and secondary wreaths, which are quite normal, being omitted for greater clearness. The moderately wide trochal discs are supported on two strong pedicels. Near the centre of each disc the trochal seta-pencil rises from a small prominence from which a low ridge (*r. r.*) continues to and over the inner margin of the disc, the ridge from either disc dipping to meet that from the other. As these ridges arise at the nerve centre of the discs, I surmise that they protect nerve branches passing towards the median line. I have not seen them so well developed in any other Bdelloid and rarely even rudimentary. Between their junction and the moderately high upper lip (*u.l.*) is visible a fleshy nexus (*n.*) connecting the pedicels and extending nearly up to the level of the discs.

In all my specimens, the food-pellets were of unusually small size. The characteristic wildness of the animal is greatly modified if it be kept for a week or so in a small trough or cell. Examples thus confined produced eggs of oval form, but proportionally longer than customary among Bdelloids. The embryo developed very rapidly, and the young rotifer emerged in about six days, about half the usual period.

DAVID BRYCE.

ON FLUID MOUNTING.—There is no question that with very many classes of objects fluid mounting is the best, as the preparation is shown without pressure or distortion, and the natural arrangement of the parts gives a true idea of its real nature. Many of us, however, bar fluid slides altogether owing to their usual habit of leaking after a short period, and it is to obviate this fault that the present note is given. The first essential of a cemented joint is usually as close a joint as possible with a minimum quantity of the adhesive. This, as is ordinarily tried with marine glue, gives a perfectly sound joint of the ring to the slide, but owing to the unequal expansion and contraction with temperature changes of the fluid mountant as compared with the glass, the rigid setting sooner or later gives way and the slide is ruined. What is really required is a cement sufficiently hard to be adhesive, rigid enough to bear handling, yet elastic to stand the trifling differences of volume required with temperature variation. Hence a sufficient quantity of an elastic cement must be used to accommodate by its own variability the necessary changes. Such a cement can be made as follows:—A penny tube of cycle rubber solution, which is rubber in naphtha, is emptied into a four-ounce bottle and double its volume of old gold size added, shaking till thoroughly mixed. This must now be placed on a water bath or anywhere to be heated not beyond one hundred and fifty degrees in order to drive off the naphtha and any volatile constituent of the gold size. Whilst this is being done, prepare a thick solution of shellac in absolute alcohol (not methylated spirit) and add, when the other solution is naphtha-free, twice its volume of shellac solution as thick as treacle. Stir whilst hot and filter through fine muslin before cooling. It can be thinned as desired with absolute alcohol. The reason why methylated spirit cannot be used is that the denaturant which evaporates with the spirit may evaporate inwards and be condensed in the fluid mountant, and I have seen many slides spoiled by a milky fog caused by the condensed denaturant, which is not transparent when mixed with water any more than methylated spirit is. The quantity required is not large, so absolute alcohol is not prohibitive.

Use the mountant as thickly as it can be worked to flow and make a heavy ring on the slide. Of course, it is preferable to do a fair quantity at one time. This sets in about fifteen minutes and dries reasonably hard in a day. This ensures perfect contact of the cement to glass slip. To cement the rings I take a scraping of soap from the piece in use, and spread it on the turntable centre. A ring flatted on coarse emery cloth if metal, or coarse sandpaper if vulcanite, can be pressed on to the soap and adjusted centrally with sufficient firmness to be cemented all round, leaving a more level ring than can be otherwise obtained. The next day, or later, a thin ring of cement can be put on the slip and the ring adjusted in place. When hardened you will have perfect contact of cement and glass, with perfect contact of cement and ring, with an elastic layer of cement in between, which is capable of absorbing any small variation under the exercise of pressure. A ring fixed in this manner is likely to remain permanent if the further mounting operations are properly performed.

C. E. HEATH, F.R.M.S.

MICRO-FUNGUS FROM THE JAPAN-BRITISH EXHIBITION.—A friend who visited the Aino village in the Japan-British Exhibition last year at Shepherd's Bush, happened to pull out a straw from one of the native huts. He found it was rice straw and had been brought from Japan specially for the construction of the huts. Some minute dark spots on a leaf proved on examination under the microscope to be patches of a fungus. It is one of the Puccinias, a genus

FIGURE 1.

FIGURE 2.

of which there are very many species, growing on various plants and widely distributed. Dr. Cooke records no less than seventy-eight for Britain alone, "Microscopic Fungi" p.p. 202–212. The well-known "Mildew" on wheat is one of them, *P. graminis*, and the example found on the rice straw closely resembles it, though probably, as living on another host, it would be considered a separate species. The patches (sori) are found on both sides of the leaf in this case, and are made up of very numerous double spores, attached to stalks often of considerable length, Figure 1. The mature spore has a thick outer coat of a rich brown colour, and a thinner one within. At the apex an opening through the thick coat can be seen, and the lower spore has a similar opening—usually rather difficult to make out—on one side just below the cross wall, Figure 2. Through these openings, on germination taking place, a tube is protruded, the further end of which divides into three or four cells each bearing a very small spore on the end of a short branch, Figure 2. It is these extremely minute secondary spores which propagate the fungus. In many species they do not reproduce a Puccinia such as they arise from, but another form known as "cluster cups," an elegant little fungus well known to microscopists. This may be produced on the same or on a different species of host plant, with many variations in the details, for the life history in most cases is very complicated. Immense loss is caused to farmers and horticulturists, as the fungi weaken and even destroy the plants on which they grow.

J. B.

THE SCALES OF LEPIDOPTERA.—Some time ago I received from a correspondent in South Africa some curious pupae which he had found suspended by threads from one of the branches of a bush. They were sent in spirit which did not seem to have injuriously affected either their form or colour. On examination they were seen to be in different stages of development, the imago in one being apparently on the point of emergence. Upon carefully removing the enclosing membrane from this, I extracted a butterfly which

XUM

appeared to be perfectly mature, except that the wings were shorter than the body, as is usual when the insect first bursts from the pupa case. It had often been a matter of conjecture how it was that when the wings of a butterfly were fully expanded a few hours after emergence, the scales were all perfectly formed and covered the entire wing surface by overlapping at their lower edges like tiles when laid on the roof of a house. It did not seem possible that if the scales were fully formed and covered the wings in the same manner when only one third of their ultimate length, they could also cover the expanded wing so completely as we find to be the case in the mature insect. On setting the specimen referred to, and placing it under the microscope, the mystery was at once solved by finding that the scales were all there and in perfect condition, but instead of lying flat they were standing on end attached to the membrane of the wing in the usual manner, but so close together that the coloured pattern formed by them could be distinctly made out. In this position,—just as roofing tiles take up less room when standing close together on edge,—the scales then occupied a minimum amount of space, and it seemed clear that as the membrane expanded it would draw their stalks farther apart, and at the same time cause them to lie down, and in this way cover a greatly increased area.

R. T. LEWIS, F.R.M.S.

THE ROYAL MICROSCOPICAL SOCIETY.—April 19th. H. G. Plimmer, Esq., F.R.S., President, in the chair. Mr. E. J. Spitta gave a demonstration of low-power photomicrography with special reference to colouring methods, in which he showed some fifty coloured slides which had been coloured by an artist friend by a completely new method.

Mr. Spitta also communicated a report on Grayson's Rulings presented by Mr. Conrad Beck to the Royal Microscopical Society, which embodied the results of many thousand observations.

Mr. E. J. Shepherd read a paper on "The Re-appearance of the Nucleolus in Mitosis," which formed an addendum to his previous paper, communicated in April, 1909, on "The Disappearance of the Nucleolus in Mitosis." In the present communication he said that with a view to ascertaining how and when the nucleolus makes its re-appearance, the diaster stage is the one which calls for most careful study and observation. At or about the time of the formation of the dispirem, and before the diasters have lost their characteristic shape, a looping in the chromatin is observed—the number of loops varying in each daughter nucleus. It is in these loops that the nucleoli will appear, but it must not be inferred that a nucleolus will appear in each loop, as there are frequently more loops than nucleoli. The latter make their appearance when the division of the cell is well marked, and when the interzonal fibres have generally disappeared. From the results of his research, he was of opinion that the nucleolus is a product of the chromatin injected into the loops by a process which can best be described as a "streaming in" process. A full account of the technique of the staining and methods adopted, and so on, which have led to the above conclusion, will be found in the *Journal of the Royal Microscopical Society*.

Mr. J. Murray communicated the second portion of a report from the Shackleton Antarctic Expedition of 1909, on the Canadian Rotifera. Forty-two species (all Bdelloids) were collected among mosses. They included five new species—*Callidina asperula*, *C. canadensis*, *Mniobia obtusicornis*, *M. montium*, *Habrotrocha maculata*. There were also a number of peculiar varieties of other species. *C. asperula* has since been found in Ireland by the Clare Island Survey. Twenty-seven Bdelloids were previously recorded for the United States. Six of these occurred in their collections, so that the number of Bdelloids now known in North America stands at sixty-three species, but a number of these are of doubtful value. Among the rarer Canadian species were *Philodina australis* (Australia and Canada), *Callidina speciosa* (British Guiana and Canada), *C. zickendrahti* (Russia and Canada).

A description of a new piece of apparatus for photomicrography, with the microscope in the inclined position by Señor Domingo de Oureta, was read by the Secretary.

QUEKETT MICROSCOPICAL CLUB. — April 25th, 1911. Professor E. A. Minchin, M.A., F.R.S., President, in the chair. Dr. A. C. Coles, of Bournemouth, sent a note describing the advantages of Parolein as a mounting medium. Its refractive index is 1·471, as against 1·530 for balsam in xylol. It is absolutely neutral, and, so far as is known at present, is entirely without action on any dyes. It is rather more trouble to use than a balsam, as, being a liquid, the preparations require to be ringed with some cement which is also neutral. (A detailed account of the methods employed by the author will be found in *The Lancet* for April 1st, 1911.) A number of bacterial preparations mounted in parolein were exhibited under microscopes lent by Messrs. H. F. Angus & Co.

The President exhibited and described: (1) Cysticercoid of the rat-tapeworm *Hymenolepis diminuta* from the body-cavity of the rat-flea, *Ceratophyllus fasciatus*, with head invaginated. (2) The same, with head extended. (3) Another species of cysticercoid, probably *H. murina*, also from the body-cavity of the rat-flea. (4) Ventral nervous system of *C. fasciatus*. (5) Salivary gland and duct of *C. fasciatus*. These preparations were displayed under microscopes, also kindly lent by Messrs. H. F. Angus & Co.

The Honorary Treasurer, Mr. F. J. Perks, read "Some Notes upon Seeds as Micro-Objects" contributed by Mr. N. E. Brown. It was recommended that the specimens be mounted in cells, dry, on clear glass slips, not on a dark ground, and fixed in position with seccotine or gum. For illuminating, a spot lens and concave mirror below the stage, together with a stand condenser to give top light, were used. Added beauty is obtained if coloured gelatine, say red, is placed below the spot-lens, and a green gelatine held over the stand-condenser. Some of the more beautiful varieties were then described, among which may be mentioned *Pterosperma andromedea*, *Paulownia imperialis*, *Philydrum lanuginosum*, *Nemesia Strumosa*, *Elionurus elegans*, and *Sesamum capense*.

Mr. D. J. Scourfield, F.Z.S., F.R.M.S., made some remarks on "The Use of the Centrifuge in Pond-Life Work." He had recently been experimenting with a hand-driven form running at about seven thousand revolutions per minute. The tubes held only about one-and-a-half c.c. instead of the usual fifteen c.c. It was found that if plain water be taken from any pond in a tube without a net, and centrifuged, there are obtained numbers of very minute flagellates, very small heliozoa, diatoms and desmids, and a great variety of immature forms. The size of these organisms was of the order of the one-thousandth of an inch (25μ). There was a considerable field for work on what had been christened the "centrifuged plankton." He had observed quite a number of forms new to him, but could not yet say if they were really new. Certainly some of them had never been named.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

JUDGMENTS ON THE ROOK. — Mr. Walter E. Collinge has recently been investigating the feeding habits of the rook, and gives his finding in his *First Report on Economic Biology* (Birmingham, Midland Educational Coy., 1911. Price 2/6 net.) He is strongly of opinion that we have too many rooks, as they are distinctly destructive to cereal and root crops, game, and so on, and that they should be systematically reduced in number and held in check. This verdict is supported by the results obtained from examination of the stomach contents of eight hundred and thirty rooks shot throughout the year 1908–9, in England and Wales, and (to continue using Mr. Collinge's own words) showing:—

(1) That 67·5 per cent. of the food of the rook consists of grain; if to this we add that of roots and fruits, the percentage is raised to 71 per cent.

(2) The animal food-content was only about 29 per cent., of which quite one-third must be reckoned against the rook.

(3) There is ample evidence to show that, with the present large numbers of rooks, a grain diet is preferred.
(4) So far as the evidence of this enquiry shows, the rook is not a particularly beneficial bird to the agriculturist, although its usefulness might be considerably increased were it fewer in numbers.

This is even more condemnatory of the rook than the figures which are given in the *Transactions of the Highland and Agricultural Society* for 1896, as the result of investigations made by Sir John Gilmour in Fifeshire. During one year, about thirty rooks were shot and examined each month—three hundred and fifty-five birds in all—and it was found that eighty-one per cent. of their food was cereal grain and husk, with insect and grub; also that grain and husk were at least as frequently met with as insects and grubs. It is stated that grain and husk is above everything the food of the rook, and that a general crusade throughout the country should be waged against rooks and rookeries.

On the other side Mr. Robert Newstead's opinion is that the rook is, on the whole, decidedly beneficial, though quite omnivorous and a great destroyer of grain. (*The Food of some British Birds*, 1908.)

The rook is scheduled, along with the starling and chaffinch, as the subject of the first enquiry by the Economic Ornithological Committee of the British Association as to the food of birds, and, from this, further reliable data and facts may be expected to be forthcoming ere long.

DECREASE IN THE CORN-CRAKE OR LAND-RAIL (*CREX PRATENSIS*).—In recent numbers of *The Zoologist*, correspondents have been giving instances of changes or fluctuations in the numbers and distribution of some of our commoner birds. To the present writer the most interesting case is that of the Corn-crake. Within the last few years he has had some opportunity of comparing, by field observations, the bird-life of the Home Counties with that of the West of Scotland, and, as regards the Corn-crake (a most familiar species in the last-named district), he has only once heard it in the course of many outings each season in Middlesex, Herts and Bucks. That was on 5th June, 1910, near Great Missenden, Bucks. This is so greatly at variance with the statements made in local bird-books, that some explanation or fresh examination seemed necessary. This has been forthcoming in some details from the various contributors to *The Zoologist*, who unite in agreeing that this bird, once abundant and common, must now be considered scarce over a wide area including Berks and the Thames Valley, Oxfordshire, Bedfordshire, Staffordshire, Surrey and Hants. It is, in one way, consolatory to the present writer to find Mr. O. V. Aplin, author of "The Birds of Oxfordshire," (1889), saying that he heard the Corn-crake at Bloxham, in 1910, but had not done so since 1904.

The scarcity is attributed to destruction of the birds and their nests by mowing-machines, by birds being killed by flying into telegraph and telephone wires, by unseasonable summers and by wetter meadows along the Thames and its tributaries. But the question may well be asked why the species holds its own in the West of Scotland, where such conditions are quite as prevalent as elsewhere in the country.

THE RED GROUSE ON THE CONTINENT.—This typical British species *Lagopus scoticus* seems now to have obtained a secure footing on the Hohe Venn, an elevated region of moorland situated along the Germano-Belgian frontier, South of Spa. The first introductions were made in 1893, but were unsuccessful. In August, 1894, fifty pairs were imported, and by the following autumn they had spread all over the locality named. In 1901, it was estimated that there were one thousand birds in the two "Kreise" of Malmedy and Montjoin. Professor W. Somerville, who gives this information in *The Ibis* (April, 1911, page 368), flushed a strong covey in a short walk over the moor in September last.

A NEW BRITISH BIRD.—Fair Isle has again yielded an addition to our avi-fauna, Mr. Wm. Eagle Clarke reporting in the current number of the *Annals of Scottish Natural History* (page 70) that an example of Blyth's Reed-Warbler (*Acrocephalus dumentorum*) was obtained there in September, 1910. This species resembles the Reed-Warbler, and Marsh-Warbler closely in colouration, and very careful comparison is required to distinguish these three forms. It is eastern in range and is not known to have occurred previously west of St. Petersburg.

WHITE STORK BREEDING IN THE "ZOO," LONDON.—A pair of White Storks (*Ciconia alba*), which were placed in the sea-gulls' aviary about a year ago, built a nest there on the ground, laid three eggs, and after twenty-eight days' incubation, hatched one egg on the 1st May. The young bird seemed doing well some days thereafter, and it is hoped may be successfully reared, as this is the first time this species has bred in the Zoo.

COLLECTING AND PROTECTING BIRDS OF PARADISE.—A great collector describes in the current number of *The Ibis* (April, 1911, pages 350–367) sixteen new species and sub-species of Birds of Paradise published since 1898, and also gives a complete revised list of all the known birds of this group. This makes a considerable addition to our knowledge, the information being given for high scientific purposes and for the advancement of knowledge. Trinomials are largely used, and such names occur as *Lycocorax pyrrhopterus pyrrhopterus* (Bp.).

A bird "collected," either scientifically or unscientifically, is accounted for in a final and effective method, although its remains may be treasured in a museum, and it is something of a coincidence that the same number of *The Ibis* (page 403) contains a plea for preserving Paradise-Birds "from the utter extinction which will certainly befall them unless some steps are taken to guard them from destruction." This remark is made in commending the action of Sir William Ingram, who has acquired the island of Little Tobago, West Indies, for the purpose of an experiment in acclimatizing Paradise-Birds. This is an uninhabited island, except for the keeper who has been placed upon it to look after the forty-eight living examples of *Paradisea apoda*, brought from the Aru Islands and set free on Little Tobago. We trust that the experiment will command success and shall look forward to hearing of satisfactory results.

THE BRITISH ORNITHOLOGISTS' UNION EXPEDITION TO THE SNOW MOUNTAINS OF NEW GUINEA.—The members of this expedition are now all returning home, and were to sail from Singapore on 5th May. Insurmountable difficulties have prevented complete success attending their efforts, but they attained the top of the first great mountain-range near the snows; and considerable collections of birds, mammals, and other objects, have been made, which are expected to yield valuable scientific results. A number of letters from the leader, Capt. Rawling, appear in *Country Life* (20th May, pages 719–23).

PHOTOGRAPHY.

By C. E. KENNETH MEES, D.Sc., F.C.S., F.R.P.S.

THE ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION.—The Fifty-sixth Annual Exhibition of the Royal Photographic Society was opened on May 9th, at Prince's Skating Club, Knightsbridge, W.

The Exhibition of pictures was of considerable interest, the general collection being augmented by a special loan collection of photographs of His Majesty, King Edward VII, a number being lent by Her Majesty Queen Alexandra.

The Pictorial Section was generally considered to be a satisfactory and representative display, and an interesting new experiment was the Section for General Photography, in which the pictures were selected for their technical merit.

While some very fine work was shown in this Section, notably Dr. Thurstan Holland's photograph of the Bernese Oberland, one cannot help feeling that far more first-class

technical work is available than was shown, and that when the Section has become more familiar to Exhibitors much better results may be expected.

In Section 3, devoted to Colour-Photography, many transparencies of scientific interest were shown. Professor Waymouth Reid showed a splendid collection of Autochromes, including a very large and fine polarised light figure of the mineral Barytes. Other polarisation colour-slides were shown by Professor Pope, J. G. Bradbury and A. W. Harris.

There is no doubt that for the demonstration of polarised effects the Autochrome plate will prove most suitable, and should in the end win an important place for itself in the class teaching of Mineralogy.

Of Botanical work also there were many fine examples; the Alpine flowers of Mr. Somerville Hastings being conspicuous.

Dr. Drake Brockman showed a number of moths and butterflies, while Mr. Martin Duncan, Mr. J. I. Pigg and Mr. P. C. Dallinger, as well as Prof. Waymouth Reid, showed photomicrographs in colour.

As a whole the Colour Section must be considered excellent in quality, and thoroughly representative of the valuable work that can be done on screenplates.

Of Natural History Photography the present writer is scarcely competent to speak, but to an outsider the Section seemed a good one, and many interesting photographs were shown.

Technically, Mr. H. C. Knowles' photograph of the Great American Egret, reproduced in the Exhibition Catalogue, is excellent work, while the Yawning Jaguar of Mr. H. Irving, strikes a rather unusual note. Mr. C. J. King contributes a series of patient studies of Peregrine Falcons, and indeed the Section is unusually rich in series of photographs illustrating the life-history of birds and beasts, in which perhaps the chief scientific value of Natural History photography is to be found. An excellent example was the series of twelve prints illustrating the life-history of the Nightjar during the nesting period, by Mr. William Farren. Mr. Pike's photograph of the Gannet going down wind will appeal to most photographers and makes one inclined to suggest that it might be an improvement to this Section, even at the cost of enlarging the Catalogue, if fuller particulars of the way in which the photographs were taken were given.

Section 5, which is devoted to Scientific Photography and Reproduction Processes, was particularly strong this year, both the Photomicrographic and X-Ray sections being very representative. The Astronomical section, containing a large number of very high-class transparencies, is liable to be somewhat ignored by the general public. It would perhaps be better if astronomical workers were to prepare prints from their negatives for such an Exhibition, even though transparencies show more detail and better render gradation. Transparencies are very difficult to hang and light satisfactorily in an Exhibition, and are therefore liable to be separated from the rest of the scientific section, and to suffer in consequence.

The first eight frames of the Scientific Section were a collection of examples of new methods of process reproduction shown by the London County Council School of Photo-Engraving and Lithography; they comprised frames showing the new Rotary photogravure as applied to newspaper illustration, and also the improvements in relief methods which the introduction of intaglio processes has stimulated. There was also an excellent frame showing Rotary photogravure in colour, and another showing Photolithography in colour from half-tone transfers printed by the off-set process.

Immediately after these the photomicrographic section commenced with a splendid series of high-power photomicrographs of diatoms by Dr. T. W. Butcher, which have received a well-deserved medal. Conspicuous in this section also were the pathological photomicrographs of Mr. Richard Muir, and the bacteria and trypanosomes of Dr. Duncan J. Reid, an interesting frame, No. 633, by the latter giving full particulars of the photographic conditions under which a number of varying objects were taken. A careful study of this frame could not fail to be of use to any worker in this subject.

Mr. C. R. Darling showed a series of photographs of drop formation, the drops consisting of aniline oil suspended in water.

One of the best photographs, technically, in the whole Exhibition was Mr. H. N. Newton's photograph of a dissected human heart, No. 653, which showed the ventricles and valves with strengthening cords. A large number of photographs of osmotic growths was shown by Dr. Stephane Leduc, and others were contributed by Dr. J. Gray Duncanson.

The Radiographic Section vied with that dealing with Photomicrography in being fully representative and of the highest order. The medal was given to Dr. Thurstan Holland for his numerous photographs, and was no doubt awarded as much for the general excellent work which Dr. Holland has done in perfecting X-Ray technique as for the special photographs shown at this Exhibition. As Dr. Holland also received a medal for his photograph in Section 2, he is in the unusual position of receiving two medals in the same Exhibition.

Other excellent radiographs were shown by Dr. Robert Knox, whose technical skill closely approaches that of Dr. Holland's, and by Dr. G. H. Rodman; while two photographs of the highest class were sent by Dr. G. T. Haenisch.

The Astronomical Section of the Exhibition was mainly represented by the many transparencies shown by the Lowell Observatory and by Dr. Max Wolf of Heidelberg. Dr. Wolf showed a collection of no less than 50 lantern slides, while Lowell Observatory sent a series of photographs of Saturn and Jupiter, and of Comet *a* 1910 and of Halley's Comet, the spectrum of Halley's Comet being also shown.

In Spectroscopy, Professor Zeeman received a medal for his absorption lines of Sodium in a magnetic field, the resolution being very clearly shown. The definition which can be obtained in Spectroscopy under the best conditions was well shown by Mr. Stanley in his enlarged photographs of the iron and aluminium arc spectra.

Many other interesting photographs were shown, but one cannot help feeling that an Exhibition such as this might be made much more fully representative of the application of photography to science, if scientific workers generally would take more interest in it and endeavour to make use of the opportunity of laying their results before the general public.

PHYSICS.

By A. C. G. EGERTON, B.Sc.

OPTICAL PROPERTIES OF VAPOURS.—Professor R. W. Wood has recently delivered three lectures at the Royal Institution, on the optical properties of vapours. These lectures were illustrated by experiments, illustrating most beautifully the various phenomena referred to by the lecturer, who is a master of the art of designing experiments and whose ingenuity is unbounded.

His first lecture dealt with the absorption of light by vapours. Many substances have a definite colour in the gaseous state; nitrogen peroxide is brown, iodine vapour violet, chlorine green, nitrosodimethylaniline green—a few of many examples. If light, after passing through such gases, is analysed by a spectroscope, the spectrum will be crossed by dark lines and in some cases by dark bands. The light of these wave-lengths corresponding to the dark lines and bands has been absorbed by the vapour. In the same way the light from the photosphere of the sun is absorbed by the layers of vapour round the sun constituting its atmosphere: dark lines then make their appearance in the sun's spectrum corresponding to the elements in the state of vapour in the sun. At the time of an eclipse, when the moon hides the sun's disc-like form, the spectrum of the corona is often found to contain bright lines in the neighbourhood of prominent absorption bands in the solar spectrum, those about the yellow sodium lines being peculiarly prominent. It was not easy to explain how the "reversing" layer, or the layer of gas responsible for the absorption of the light from the photosphere should be hot enough to emit light of its own. This particular bright

line spectrum has been termed the "flash" spectrum. Before being able to give the true explanation of the flash spectrum, it is necessary to explain what is meant by dispersion.

If white light be passed through a glass prism, it is not only bent and deviated by an amount proportional to the "refractive index" of the glass, but it is also split up into a spectrum, the red light being less deviated than the violet; this is termed the "dispersion" of the light. Now light is refracted more by a dense glass prism than by a light crown glass prism of the same angle, but it does not necessarily follow that the dispersion is proportional to the "refractive" power (*i.e.*, to the refractive index) of the glass. It is this that makes it possible to construct achromatic prisms and lenses; the dispersion of one prism can be counteracted by that of a dense flint glass prism though the deviation or refraction of the beam of light is still obtained. Newton arrived at the conclusion that dispersion was proportional to refraction; this was erroneous. If the refractive indices be plotted against the wave-lengths of the light passed through various substances, it is not always found that the substances of high mean refractive index give great dispersive powers, or steep curves, when plotted as mentioned.

Kundt found in examining the absorption spectra and dispersion curves of many dyes, that such highly coloured substances which show strong absorption bands, give what has been termed "anomalous dispersion" in the neighbourhood of these bands. Instead of increasing as the wave-length decreases, the refractive index increases very rapidly on the red side of the absorption band and decreases towards the blue side of the band. "Normal" dispersion is merely a particular case of the general phenomena of dispersion; the band near which the dispersion is "anomalous" lying, for transparent colourless substances, in the ultra violet invisible region of the spectrum.

Returning now to the sun and considering its "flash" spectrum, it follows that the refractive index in the neighbourhood of an absorption band, due to some vapour or other, will increase very rapidly; it will be very small except close to the absorption band, hence light nearly corresponding in wave-length to the absorption band will alone be sorted out and bent sufficiently for it to reach the earth, when the moon has blocked out all direct light from the photosphere. This beautiful explanation is due to W. H. Julius, but Professor Wood has been able to reproduce the phenomenon experimentally, thus confirming the correctness of the theory.

It will be well first to describe Professor Wood's method of illustrating the anomalous dispersion of sodium vapour. A long glass tube with pieces of sodium strewn on the bottom is fitted with plate glass ends and exhausted. It is then heated by carefully adjusted Bunsen burners. The upper surface of the tube being cool, the density of the vapour decreases as its distance from the heated sodium. It then forms what is equivalent to a prism of sodium vapour. Light from an arc lamp passed through a slit and then through the sodium prism is absorbed by the vapour which, by the way, when dense, has a blue violet colour; particularly absorbed are those wave-lengths corresponding to the yellow "D" lines. There are also absorption bands in the green and red. Now, in the neighbourhood of the "D" absorption bands, the vapour will have an abnormally high refractive index for waves slightly longer than those which it absorbs and an abnormally low refractive index for waves slightly shorter than those which it absorbs. Thus yellow light passing through the sodium vapour prism will be very highly dispersed, the wave-lengths on either side of the absorption bands being most widely separated. If the light be now observed in a spectroscope with the refracting edges of the prisms at right angles to the edge of the sodium prism, the light in the neighbourhood of the "D" absorption lines will curve up on the one side of the band and down on the other side owing to the great dispersion of the sodium vapour for light of wave-lengths in this neighbourhood. Professor Wood was able to project the artificial "flash" spectrum of sodium on the screen. Light from an arc is projected through a narrow horizontal slit along the lower edge of a metal plate heated by a Bunsen fed with sodium which colours the flame yellow. The light on leaving the plate is almost completely screened off, passed through a prism and projected on the screen. The metal plate lowers the temperature of the flame and the sodium vapour no longer emits light in its neighbourhood. The light passing through this layer of sodium vapour is anomalously dispersed in the yellow region. The rays on either side of the absorption bands are refracted differently, the one ray being bent upwards and the other down. The screen being adjusted to cut off the direct light from the arc, the yellow light bent upwards suddenly "flashes" out on the screen. This then illustrates what is occurring in the sun's atmosphere.

The second lecture dealt with the emission of light by vapours. Vapours can be made to emit light by the passage of electricity through them when the electrons in the ions are greatly disturbed and set in vibration. The disturbance in this case is effected by many causes; it is better then to look for a less complicated method of setting the electrons in vibration in order to discover something about the structure of the atom. Those vapours which absorb light and hence have a definite colour can be made to emit light by heating them. Professor Wood showed how iodine dropped into a quartz bulb heated to a high temperature, is vaporised and glows—the vapour appearing "red-hot." White light passed obliquely through a steel tube in which sodium is vaporised causes the sodium to fluoresce or emit light of a green colour by stimulation. In the same way light passed through a bulb containing iodine vapour at a very low pressure causes the vapour to fluoresce with an olive green hue. The presence of a small quantity of helium changes this hue to a reddish tint, while other gases destroy the fluorescence in proportion partly to their molecular weight and partly to their electro-negative character; a very small quantity of chlorine destroys the fluorescence altogether. Mercury vapour will fluoresce at much higher pressure; Professor Wood illustrated this point by projecting light from a magnesium spark on a quartz bulb in which mercury was boiled; the mercury vapour, when all the air had been expelled from the flask, lit up with a blue colour. Iodine when heated emits light of the same wave-length as it absorbs; the electrons in the molecule are set in vibration by the process of heating the vapour and give out particular wave lengths of light, just in the same way as these waves are absorbed on passing through the vapour, their energy being absorbed by setting in motion those electrons which vibrate with the same period of vibration. White light passed through such a vapour, provided the pressure is not great enough to prevent the free vibration of the electrons by the collision of the molecules, will give rise to fluorescence. If instead of employing white light, light of a particular wave-length be employed, then this light will affect only certain electrons which vibrate with the same period, and these in turn being grouped with only a few other electrons in the molecule will set in vibration only a few other electrons possessing different periods of vibration; only a few lines then appear in the spectrum of the light from iodine vapour set resonating by the light from the mercury arc. Professor Wood has studied these resonance spectra most elaborately and amassed much interesting material from which to obtain a glimpse of the atomic structure.

The third lecture dealt with the effect of magnetism on the optical properties of vapour. Light from an arc lamp was passed through a well-evacuated tube containing sodium vapour placed across the poles of an electromagnet; the light before it entered the tube was polarised by a Nicol prism and only permitted to vibrate in one plane. On emerging from the tube, the light was passed through a second Nicol prism, so that the prism either permitted the polarized light to pass or, by setting it at right angles to the plane of vibration of the waves, it could prevent the light from reaching the screen. An ordinary glass prism refracted the emerging light on to a screen and formed a spectrum on the screen. The second Nicol was so arranged that it almost extinguished the spectrum. The magnetic field was switched on and immediately the sodium yellow lines could be easily seen on the screen. In this experiment the magnetic field rotates the plane of polarization round through a right angle or some multiple thereof, thus

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permitting the light to get through the second prism. The rotation is only produced where the refractive index of the vapour is very high, namely in the neighbourhood of the sodium flames. If the sodium vapour be very dense, the beam of yellow light will be twisted round and round many times. The light examined in the spectroscope is shown to consist of a number of light and dark spaces on each side of the "D" lines, each line representing a rotation of the beam through 180°. In some cases the direction of the rotation of the plane of polarization is opposite to that of other wave-lengths, which Professor Wood has shown by means of a most ingenious double quartz prism of right and left handed rotation. The rotation of the plane of polarization of the light in the neighbourhood of the absorption bands of iodine was shown; the little monochromatic elements in the spectrum are selected out and give a line spectrum. Professor Wood referred finally to the reflecting power of vapours which if the absorbing power is great should also be great. He has been successful in obtaining reflection from mercury vapour under high pressure in quartz vessels when illuminated by ultra-violet light.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

ARTIFICIAL PARTHENOGENESIS.—It is now reported that the eggs of frogs and toads may be got to develop without fertilisation. Bataillon takes a piece of a string of toad's spawn with as little jelly as possible, puts it in a dry dish, bathes it with a little blood, and makes minute punctures in the eggs. They segment "magnificently," and the frog's blood works as well as the toad's, and better than the spermatozoa of the frog! Dehorne has made a careful study of a frog larva parthenogenetically produced which lived for eight days. The cells of its body had, as theory would lead one to expect, only six chromosomes in their nuclei,—half the normal number.

A CURIOUS HABIT.—Erik Bergström calls attention to a puzzling piece of behaviour which he has noticed in reindeers at the time of antler-growth. With some difficulty they frequently bring the tip of the antler into contact with the hoof-gland, and the result is that the tip is smeared with the viscid secretion. But why?

RINGS ON FRESHWATER MUSSELS.—There is some peculiar satisfaction in observing the organic registration of growth-periods,—so familiar in the rings of wood on the sawn tree-stem. It is striking, too, to read back to a peculiar line where there seems to have been no summer wood formed, and to find, on consulting the meteorological calendar, that this corresponds to what was called "the black year," when there was no summer. So from the scales of a fish, or from its otoliths, or even from some of its bones, one may read its age with security, corroborating one index by another. According to Malloch one can tell from the salmon's scales whether it has spawned or not, and more besides. A case that has always interested us, because of the great variety in the succession, is that of the rings on freshwater mussels, but we are not aware of precise observations on the subject. In a recent paper Israel points out that two rings are sometimes laid down in one year.

FLIES AND ERGOT.—We have heard much in recent years of the part that flies play in disseminating disease-germs —typhus-bacilli, sleeping sickness Trypanosomes, and many others. It is interesting to notice that L. Mercier has found that a common summer fly, *Sciara thomae*, carries about the spores of *Claviceps* which causes ergot on rye-grass. The conidia of the *Claviceps* were abundant in the food-canal of the fly and did not seem to be affected. There were also others on the setae of the body. The flies frequent rye-grass, but experimental proof that they infect healthy plants with *Claviceps* has not yet been furnished.

SPIDERS AND MOSQUITOES. — N. Leon gives an account of the formidable numbers of Mosquitoes in Roumania along the shores of the Danube. Every here and there, in some tracts, one sees the canopied *al fresco* beds where the fishermen sleep, or try to sleep. Equally characteristic is the astonishing abundance of spiders' webs which sometimes cover the trees with a thick veil. These are of no slight importance in imposing some check on the multiplication of the mosquitoes. As things are, the plague is sometimes terrifying, but it would be much worse without the spiders.

HYDRACTINIA AND HERMIT CRAB.—Prof. Seitaro Goto, of Tokyo, describes two species of *Hydractinia* which occur in Japanese waters in association with a hermit crab (*Eupagurus constans*), and form shells of their own entirely composed of a chitinous framework. In most specimens there is apparently no basis of gastropod shell, as is the case in most other known species of *Hydractinia*. The skeleton of one of the species (*H. spiralis* sp. n.) is totally devoid of spines, and its substance is very thin and papery, while that of the other (*H. sodalis* Stimpson) is richly armed with large spines, which are conical when small, but irregular in shape and branching when large. The skeletons of this species are rather common and are sold in a dry state under the name "Igaguri-gai," or "Chestnut-burr shell."

SPECIFICITY.—The late Mr. George Sim, of Aberdeen, author of "The Vertebrate Fauna of Dee," was wont to say that he could identify any British fish from a square inch of its skin. In other words, the scales of each species have distinctive peculiarities. They show specificity. And the more we know of the members of well-defined species the more we become convinced of the unity of the organism. Distinctiveness penetrates into every hole and corner. A striking illustration has recently been given by W. J. Loginoff, who shows that the ciliated cells lining the windpipe of horse, ox, sheep, and so on, are so distinctive in each case that it is not very difficult to tell from a preparation what animal it came from.

By WILFRED MARK WEBB, F.L.S.

THE FAIRY SHRIMP.—It is interesting to record that Mr. B. J. Hunter has recently found examples of the Fairy Shrimp in ponds near Pewsey in Wiltshire. Commenting on the fact mentioned by Mr. Pyman ("KNOWLEDGE," Volume XXXIII, page 251) that the styles projecting from the telson of the female were usually broken, Mr. Hunter says that he noticed "a small animal that seemed to have a bivalve shell, which propelled itself rapidly through the water by means of its feet, attached itself to these styles and ate them, the shrimp appearing not to notice it until it had reached quite a distance when, by means of a powerful jerk, it was thrown off."

FLEAS AND PLAGUE.—In "KNOWLEDGE," Volume XXXIV, page 12, Mr. Grew, in dealing with the question as to whether there was much likelihood of fleas carrying plague in Europe, gave the generally accepted opinion that the European rat flea, *Ceratophyllus fasciatus*, will not feed on man except when starving. Quite recently a number of experiments have been made at the Lister Institute of Preventive Medicine by Dr. Harriette Chick and Dr. C. J. Martin, which have been published in *The Journal of Hygiene* for April 8th, and Dr. Chick has kindly sent us a reprint from which we learn that *Ceratophyllus fasciatus*, when hungry, will attach itself to man with great readiness. A hundred and sixty-one experiments were made, of which we describe one. A rat was removed from a flea-breeding cage, and four days later the hand and arm of a number of persons were placed in the cage at different times during the day for two minutes. In one instance as many as eighteen fleas jumped upon the arm, many of which could be felt at once to bite vigorously.

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REVIEWS.

ASTRONOMY.

The Night-Skies of a Year.—By J. H. ELGIE. 260 pages. 113 illustrations. 8¾-in. × 5½-in.

(Leeds: Chorley & Pickersgill. Price 6/- net.)

The author adopts the course of noting down in a simple manner what he saw when viewing the sky at night, free from clouds, several times each month; it thus assumes the nature of a diary or journal, and is divided into the twelve months.

It is solely intended for those who are content to learn the positions and something of the stars in their courses; therefore, for a non-telescopic observer. The author adopts this journal form as the best way to meet the requirements of that large class of intending observers who are said to find the usual star-maps and books too full and bewildering in the number of stars dealt with. He prefers to give in the text diagrams of portions of the constellations and usually limits himself to the first, second, and third magnitude stars; in this way the most prominent and well-known configurations are represented.

Throughout the book the author, who has evidently a poetic fancy, has enlivened his bare bones of astronomical observations with historical facts, with opinions of various writers, and with frequent dives among the poets, from Chaucer's time. Though we are not enamoured with poetic effusions, being accustomed to the more solid branch of astronomy dealing with observations of facts and with figures, to those who like poetry and poetic imagination the book should at once appeal; they should not fail to obtain a copy and verify for themselves all that is stated therein, and, in learning the stars, they may contemplate upon them as suits the human mind.

The table of contents gives in detail the subjects referred to each month and a list of diagrams is similarly given. A full index of eighteen pages is at the end of the book, which is well printed in type of good size.

F .A. B.

Remarkable Eclipses.—By W. T. LYNN. (Eleventh edition). 58 pages. 1 plate. 6¼-in. × 4¼-in.

Remarkable Comets.—By W. T. LYNN. (Fifteenth edition). 48 pages. 2 plates.

(S. Bagster & Sons. Price 6d. each, limp cloth.)

There is always a freshness in the successive editions of these valuable, useful, and popular little books; not mere reprints of former editions. For beginners in Astronomy they serve both as introductions to the subject and as historical accounts. The one referring to the eclipses is quite a marvel of compactness, embracing a period of eclipses for three thousand years (B.C. 1063 to A.D. 1999), and every page is crammed with interesting scientific and historical facts. The first two pages, explaining the nature of an eclipse, might, with advantage, be extended to three or even four, and a diagram inserted. Tables of contents are given at the end. The little book relating to comets meets with our approval in a similar manner. It, however, mainly deals with the more prominent comets of the past three hundred years; the ancient records are less precise and cannot be verified so well as eclipses by ante-dated calculations. Two useful books by a trusted author. The title of these little books might be, with advantage, printed on the back: an unlabelled book on a bookshelf is a nuisance.

F. A. B.

The Stars from Year to Year.—Edited by MRS. H. P. HAWKINS. Fourth edition. 11 pages. 13 maps. (Price 1/-).

The Star Almanac for 1911.—Same editor. Second edition. Large illustrated sheet. (Price 6d.)

The Star Calendar for 1911.—Same editor. Card planisphere. (Price 1/-.)

(Simpkin, Marshall, Hamilton, Kent & Co., and others.)

These three publications are of considerable utility to all sky-watchers at night. There is an abundance of information for all enthusiastic beginners in Astronomy, and the star-maps will certainly serve them when their knowledge has emerged beyond that of a novice. These books might well be within most country households—and the stars are observed far too little by those living away from towns, with brightly lit and dusty atmosphere—whether the squire's, the parson's, the schoolmaster's, or governess's. If they were in the hands of school-teachers and those with the educational care of children, much simple astronomy might be imparted to those entrusted to them.

The prices at which these publications are offered, bring them within the reach of all; the typographical reproduction is excellent.

F. A. B.

CHEMISTRY.

The Simple Carbohydrates and Glucosides.—By E. FRANKLAND ARMSTRONG, D.Sc., PH. D. 112 pages. 10¾-in. × 6-in.

(Longmans, Green & Co. Price 3/6 net.)

Even in physiological chemistry the process of specialisation has proceeded so far that no worker may hope to keep fully in touch with more than one or two branches of his subject. It was, therefore, a happy idea of the editors of this series of small handbooks upon biochemistry to issue concise monographs dealing with separate classes of physiological compounds, so arranged that they would be useful for purposes of reference, and capable of being brought up-to-date from time to time, without the necessity of issuing a new edition of the whole series. Various companions of this book, dealing with proteins, fats, enzymes and so on, have already been noticed in these columns, and the present monograph, which is devoted to the simple sugars and glucosides, follows the same general plan. Dextrose (glucose) is taken as the type of these sugars, since, as the author points out, it is probably the first sugar formed synthetically by the plant by way of formaldehyde from the carbon dioxide in the air, and is also the form in which a large proportion of the carbohydrates in the food of animals is absorbed into the system. The chapter discussing the relationship between the chemical configuration of the sugar molecule and its biochemical properties is particularly interesting. As in the case of the other monographs of the series there is an excellent bibliography and a good index. and every chemist who is interested directly or indirectly in the subject of the sugars will find this book of the greatest use.

C. A. M.

Elementary Chemical Theory.—By J. M. WADMORE, M.A. (Oxon). 275 pages. 16 illustrations. 7½-in. × 5-in.

(Methuen & Co. Price 3/6.)

If we were asked to recommend a guide to the elements of chemical theory suitable for students at an early period of their work, we could suggest nothing better than this book. It is clearly and simply written, and the author's experience as a teacher of beginners has enabled him to anticipate and answer the chief difficulties that will arise. It deals at sufficient length with most of the subjects usually found in the larger works upon the theory of Chemistry, and has an excellent chapter upon radio-activity and its bearing upon the possible constitution of the elements. Perhaps, in a future edition, it may be found possible to devote more attention to the "phase rule," and the principles of thermo-chemistry.

Although the author anticipates inevitable criticism upon his use of the hydrogen standard for the atomic weights, and gives good reasons for its retention, we still think that an early adoption of the oxygen standard would be the better course. For since the use of H = 1 has been discarded in the annual tables of International Atomic Weights, all scientific work is now based upon the standard of O = 16. Hence to accustom students to the use of values which in practice they will have

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to unlearn, seems a greater evil than the difficulty of making the fact clear that the value 16 is only an arbitrary standard, and the possibility that some students may acquire for a time the notion that atomic weights are necessarily whole numbers. By the way, why was a table of atomic weights of 1905 chosen for the appendix? The current table contains several more elements and gives values differing in many respects from those in a table that has been out of date for five years.

C. A. M.

A Concise History of Chemistry. By T. P. HILDITCH, B.Sc., A.I.C. 263 pages. 16 illustrations. 7¾-in.×5-in.

(Methuen & Co. Price 2/6.)

It is no easy task to survey, within the limits of one small volume, the entire history of chemistry, from the days of alchemy to the present time, and in this case the difficulty was increased by the fact that the book was also designed to meet the requirements of certain examinations in the subject of historical chemistry. A book upon these lines runs the risk of being little more than a skeleton of facts, names and dates. The author, however, has escaped this pitfall, and has given us a most readable outline without sacrificing the necessary compression, and has enabled us to follow easily the development of the main theories of modern chemistry. There is also an excellent account of the history of the different elements and their chief compounds, and the book concludes with biographical notes of many of the great chemists, tables summarising the sequence of discoveries and theories, and a good name and subject index.

The chief fault in the book is the complete omission of any reference to many important branches of the science, such as biological chemistry, and the scanty treatment of other subjects. For instance, in the section dealing with technical chemistry the subject of oils and fats is mentioned, but there is no reference to any worker of later date than Chevreul; while in the account of the progress of experimental methods there is no mention of the now classical iodine absorption method of von Hübl.

The selection of the names included in the biographical notes appears somewhat capricious. Thus the names of Odling and of Newlands are omitted, while the names of many whose contributions to chemistry have been of much less weight are included. Doubtless these omissions will be remedied in the next edition.

C. A. M.

An Introduction to Chemical Theory.—Second edition. By A. SCOTT, D.Sc., F.R.S. 272 pages. 8¼-in.×5½-in.

(Adam and Charles Black. Price 5/- net.)

Slowly, out of a confused mass of painfully accumulated detail, there has been evolved a philosophy of chemistry which has shown that there was a certain law and order connecting the apparently isolated facts. Several large works upon the subject have appeared from the pens of such masters as Mendeléef and Ostwald, and the present handbook, which has deservedly reached its second edition, forms an excellent introduction to these. It takes a brief survey over the whole ground upon which the theory of chemistry has been raised, and is so fully and clearly written as to be easily followed by any student who has acquired some knowledge of the facts of the science. Among the subjects treated at considerable length in the different chapters are the determination of atomic weights, classification of the elements, carbon compounds, the principles of thermal chemistry, and solution and electrolysis, and these are illustrated by numerical examples wherever necessary.

The author's aim has been to deal only with points concerning which there is little or no dispute, and as far as possible to exclude speculative matter; but we venture to think that there has been a somewhat too rigid adherence to this rule in a book, one of the objects of which should be to stimulate the imagination of the reader. Thus the subject of radio-activity is practically ignored, although it is in this direction that most progress in the immediate future may be expected. In the few remarks upon radium (page 70) some doubt is implied as to whether that substance is really an element; but since this view is opposed to the now generally accepted opinion—an opinion based upon the properties of radium and its salts, its position in the periodic system, and its characteristic spectrum—it would have been of interest to have learned the reasons for this doubt.

The book is clearly printed in large type, and has a good index, but its use as a handbook would have been enormously increased by references to the original papers and by the addition of a classified bibliography.

C. A. M.

MATHEMATICS.

A First Book of Geometry.—By J. V. H. COATES, B.Sc. 142 pages. 127 illustrations. 7-in.×4¾-in.

(Macmillan & Co. Price 1/6.)

This book seems to have been compiled in compliance with the recommendations recently issued by the Board of Education, on the teaching of Elementary Geometry. Naturally there is nothing new except in the arrangement of the subject matter, and in some pleasing pictures of a small boy in knickerbockers engaged in "field work."

W. D. E.

Elements of Analytical Geometry.—By G. A. GIBSON, M.A., LL.D., and P. PINKERTON, M.A., D.Sc. 475 pages. 149 illustrations. 7½-in.×5-in.

(Macmillan & Co. Price 7/6.)

This book contains a great deal of matter not usually included in elementary treatises on Cartesian Geometry. Much space is allotted to the plotting of curves, and not only curves of the second degree, but some of what are usually classed as Higher Plane Curves are discussed as fully as elementary methods permit. Geometrical treatment after the manner of Euclid is freely adopted, so that the chapters on Conic Sections are a combination of analytical and geometrical methods. There was no real justification for the separation of the two in older books, and this one seems to include all the essential parts of what we used to learn as Geometrical Conics. We hoped to have found the notation of the Calculus introduced somewhere in the book. Surely it must be possible to combine the elements of Differential Calculus with the elements of Analytical Geometry in a way that is less tedious and yet not unsound. Here the authors, instead of making the beginner's yoke lighter, have added to it, and the beginnings of the Calculus seem further off than ever. But a student who has worked through this book will be thoroughly prepared for it when at length it does come.

W. D. E.

TECHNOLOGY.

Journal of the Municipal School of Technology, Manchester.—Vol. III, 1910. Edited by J. BARNES, M.A., B.Sc. 392 pages. 130 illustrations. 9¾-in.×7¼-in.

(The Education Committee.)

This journal forms a record of original investigations undertaken by members of the Teaching Staff and Students of the School in the Session 1909. In most cases the papers have been reprinted from the journals and publications of learned societies.

Although the application of science to industry is the object of the instruction given in the school, the researches contributed by the various departments are not entirely technological; theoretical investigations have not been shirked, but indeed form quite a large part of some of the papers.

Mechanical Engineering is represented by three important investigations:—Professor J. T. Nicholson's masterly research of "Heat Transmission in Steam Boilers," a further paper on the same lines by Mr. H. P. Jordan, and an exhaustive account of some experimental work on "Twist Drills." Well-illustrated dissertations on "Single-Phase Traction," "Vagabond Currents," "Flash-Over Voltages,"

and some notes on the "Elimination of Sparking" are contributed by the staff and students of the Electrical Engineering Department.

An important contribution to the subject of Ventilation is made by Professor J. Radcliffe.

A number of new methods in Volumetric Analysis are described, also a modification of the Beckmann apparatus by Dr. Knecht. The dyeing industry receives a large share of attention, especially in its application to cotton fabrics, while even the colouring matter in mummy cloths has been investigated!

Weaving, of which we should have expected to hear much, has only one short paper devoted to it. This, a twelve page monograph on "The Effect of Twist upon Yarns," consists mainly of a detailed description of three plates depicting "single" and "double" yarns in various stages of twist.

The report to the Government on the Hand Loom Industry in Bombay is also included in the volume.

The journal is printed in the Printing Crafts Department of the School, on which it reflects some credit.

P. K.

CORRESPONDENCE.

HALLEY'S COMET.

To the Editors of "KNOWLEDGE."

SIRS,—I shall be glad if any one of your readers or contributors of astronomical articles will please explain to me, through "KNOWLEDGE," why the tail of Halley's Comet was shown divided into one on the east before dawn, another on the west after dusk, instead of one on the north and another on the south, when our globe entered into the tail of the comet in the morning of the 19th May, 1910. Is the cause of the division of the tail the magnetic repulsion of the earth?

I should also like to know whether the tail of Halley's Comet actually touched the atmosphere of the earth or not?

R. G. CHANDRA.

THE ETERNAL RETURN.

To the Editors of "KNOWLEDGE."

SIRS,—I should like to say a few words on the above subject. I have dealt with the matter from the theological point of view in two letters which have recently appeared in the *New Age* criticising some articles on "Theology" by "M.B. Oxon."

First, it is necessary to realise that one's knowledge of the "external world" and the phenomena which occur there is primarily obtained by sensations, these sensations necessarily depending upon the nature of the corresponding sense organs. Most of us *think* principally in visual impressions (retinal images); and since the shape of these images depends upon the structure of the eye, it is open to question to what extent the relation of the images in the mind is a true representation of the "external" phenomena.

Space, time, force, motion are so intimately associated with "consciousness" that there is a good deal of reason for asking whether they really exist apart from consciousness. I often wish scientific people felt more than they appear to do, that whatever line of investigation into the underlying processes of nature is taken, the rock-bottom arrived at is the consciousness of the investigator. One may reduce the whole cosmos, including humanity, to motion and force—but these are *effects in consciousness*.

It is very gratifying to see the notion of space of more than three dimensions entertained by Professor Pickering. If only the conception were more readily entertained by astronomers, physicists and biologists, many astounding results might follow.

The possibility that the bodies of the solar system are something more than spheres, as a sphere or cylinder is something more than a circle—the possibility that organisms (including man) are something more than three-dimensional entities—opens up a province of speculation which might not be devoid of practical results. However, since dimension depends upon consciousness, one has to be careful in talking of dimensions of which the human mind is not "consciously" conscious.

J. JOHN ELLIOTT.

COSMIC CHANGES.

To the Editors of "KNOWLEDGE."

SIRS,—In the recent work of Dr. Alfred Russel Wallace, "The World of Life," the following statement occurs "....there have been cosmic changes due to the varying eccentricity of the earth's orbit and the precession of the equinoxes, leading to alternations of hot, short summers with long, cold winters, and the reverse; culminating at very distant intervals in warm and equable climates over the whole land surface of the globe; at other shorter and rarer periods in more or less severe "ice ages," like that in which the whole north temperate zone was plunged during the Pleistocene period. . . ."

Can any of your readers give a proof of the cosmic changes due to varying eccentricity and precession of the equinoxes?

"ANXIOUS."

IS SPACE INFINITE?

To the Editors of "KNOWLEDGE."

SIRS,—Surely it is easier to conceive of infinity than of finity? In considering this question one must assume that one has the power of illimitable flight; one must deal with the question on a practical basis. Your correspondent talks about curved space. Now, however slight is the curve, some sort of limit is suggested of which we are on one side. What is on the other? Either absolutely nothing, *i.e.*, infinity or something, in which case we should have to start afresh. To my mind the very fact of talking of finity, tacitly admits infinity. Directly one talks about a boundary, the "other side" must always be considered.

It is also interesting to speculate about time, such as we know it. Suppose that all our systems by which we measure time were taken away, and that man lived on the surface of a dark earth, let us suppose, absolutely the only sphere in existence,—would time still be considered to exist? It would exist, and yet it is strange to think upon.

C.H.E.R.

SCIENTIFIC NOTES.

To the Editors of "KNOWLEDGE."

SIRS,—In reading a paper by William R. Renwick on "Insects Destructive to Books" reprinted from *The American Journal of Pharmacy*, I came across the following which is well worth attention:—"Too little attention has been given to the manuscript notes of scientific workers, often only a line or two of their observations upon the small forms of life. The average scientific man, thinking it too trivial to notice, often passes over the very observation which is the key to the puzzle that he has been spending years in trying to solve."

It cannot be emphasized too strongly that real advance in knowledge, in any branch of science, is only to be made by the worker who pays attention to the minute details, and who regards nothing as too trifling to be worthy of record.

FRANK C. DENNETT.

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WILLIAM HERSCHEL: HIS TELESCOPES AND WORK.

By W. F. DENNING, F.R.A.S.

WILLIAM HERSCHEL completed his first telescope in March, 1774, and made his last observation in June, 1821. What a period of activity those forty-seven years included! His sister Carolina assisted him in his observations, while his brother Alexander helped him in constructing telescopes.

When Herschel came upon the scene and recognised the requirements of practical astronomy the heavens had not been explored—Nebulae and double stars existed in myriads but only in a few special instances had they been suitably recorded. He resolved to search the firmament, to reap the harvest of wonders it presented, and to properly arrange and classify them for the advantage of ages to come. So he swept the sky year after year with a skill unmatched, an energy indomitable, and a success beyond anticipation. He was a star indeed risen amid the dawn of a new astronomy. He sounded the depths of space and brought to light great numbers of interesting objects never previously discerned by human eyes. When his work was done the heavens had given up many of its secrets.

He had advanced our knowledge, in a marvellously comprehensive manner, of the great expanse around us, and posterity will honour his name as that of a great pioneer in the field of methodical observation.

Yet he was not backed up by any national institution, endowment, or observatory. He was a comparatively poor man, but with a genius within him which conceived a noble work, and mechanical abilities which enabled him to fashion with his own hands the telescopes he required. True his Sovereign encouraged and pecuniarily assisted him after he had gained renown. But without any help from George III. his great career was assured—Herschel would have been Herschel still!

The quality of Herschel's telescopes has been sometimes discussed, and the subject is interesting, though differences of opinion must necessarily exist. We can hardly think that telescopes made more than a century ago could equal the best appliances of our own day. We must have learnt something, and approached a little nearer perfection during the last hundred years. Old mirrors carefully tested alongside Calver's and With's best work might be expected to suffer in the comparison; at any rate that seems to be the reasonable inference.

But we may depend upon it that Herschel's mirrors were as good as they could be made in his day, and that they were very excellent in certain cases is sufficiently evident from his own allusions, and from the high powers he occasionally utilized so successfully.

It may in some degree elucidate the question if a few quotations are made from Herschel's writings. And in giving this evidence relatively to his telescopes I should like to mention that my intention is merely to mention facts on both sides of the case, and give no expression of opinion. At this distance of time it would be in bad taste, and certainly unjust, to disparage the instruments with which such splendid results were achieved. No doubt Herschel's powers were such that he could have made discoveries with relatively inferior instruments, but we have his word for it that his telescopes were of far different character from that.

On April 12th, 1805, he speaks of viewing "Saturn with a power of five hundred and seventy on a seven-feet mirror of six and three-tenths inches aperture and extraordinary distinctness."

Referring to the seventh satellite of Saturn, he says he "saw it very well in the twenty-feet reflector, to which the exquisite figure of the speculum not a little contributes."—August 28th, 1789.

On October 24th, 1791, with a "seven-feet reflector, having a new machine-polished, most excellent speculum, I see that the division in the ring of Saturn and the open space between the ring and body are equally dark."

An impression has prevailed that the forty-feet telescope rather disappointed expectation, and that its defining powers were certainly not on a par with its light-grasping capacity; at any rate Herschel generally used the twenty-feet and seven-feet instruments. Burnham's opinion is that some of the instruments utilized by the old observers of double stars could not compare favourably with modern refractors, and particularly with telescopes made by the Clarks. "Even when the earlier observers had powerful instruments in point of light-gathering power, as in the case of the Herschels, there can be no doubt that they were far inferior in definition."

In the *Phil. Trans.* for 1795 he gives us an idea of the number of instruments made, and says:—"When I resided at Bath I had long been acquainted with the theory of optics and mechanics, and wanted only that experience which is so necessary in the practical part of these sciences. This I acquired by degrees at that place . . . My way of doing these instruments at that time, when the direct method of giving the figure of any of the conic sections to specula was still unknown to me, was to have many mirrors of each sort cast and to finish them all as well as I could; then to select by trial the best of them, which I preserved; the rest I put by to be repolished. In this manner I made not less than two hundred seven-feet, one hundred and fifty ten-feet, and about eighty twenty-feet mirrors, not to mention those of the Gregorian form."

High magnifying powers involve a severe test of the performance of telescopes. In proof of the quality of his mirrors we may quote him as saying "In beautiful nights when the outsides of our telescopes are dripping with moisture discharged from the atmosphere there are now and then favourable hours in which it is hardly possible to put a limit to magnifying power."

But these superlative hours were all too few, alas, for he mentions he "had recourse to his journals to find how many favourable hours we may annually hope for in this climate. It is to be noticed that the nights must be very clear, the moon absent, no twilight, no haziness, no violent wind, and no sudden change of temperature, and it appears that a year which will afford ninety or at most one hundred hours is to be called a very productive one."

Herschel's favourite working instrument seems to have been a seven-feet of six and three-tenths inches aperture. Speaking of observations of Saturn he mentions that "all that magnifying can do may be done as well with the seven-feet as with any larger instrument."

The great forty-feet telescope was not used very frequently by Herschel, as its manipulation occupied valuable time and required assistance. It has been stated that this large instrument was discarded in consequence of its bad performance and cumbersomeness, but this is scarcely justified.

Herschel himself states "A forty-feet telescope should only be used for examining objects that other instruments will not reach." "The opportunities of using the forty-feet are rendered very scarce." On August 28th, 1789, he says "Having brought the forty-feet to the parallel of Saturn, I discovered a sixth satellite of that planet, and also saw the spots upon Saturn better than I had ever seen them before, so that I may date the finishing of the forty-feet telescope from that time."

This is great praise for the big instrument, but Dr. Dick in describing the details of its construction and work, as published in the *Phil. Trans.*, says: "It was not to be expected that a speculum of such large dimensions could have a perfect figure imparted to its surface nor that the curve, whatever it might be, would remain identically the same in changes of temperature; therefore we are not surprised when we are told that the magnifying powers used with this telescope seldom exceeded two hundred; the quantity of light collected by so large a surface being the principal aim of the maker." *The Practical Astronomer*, Page 304.

No doubt Herschel's object was chiefly to get as much light as possible out of his instruments, as he was constantly searching for faint nebulae, minute satellites and so on. Thus we often find him adopting contrivances, and using expedients to obtain the maximum "penetrating power."

Possessing optical and mechanical skill only matched by unwearying energy, Herschel must have succeeded in producing some thoroughly good instruments, though it should never be forgotten that his splendid observational work more indicates the measure of the man than the particular kind or quality of his glasses.

We, at the present day, cannot fairly judge as to the degree of perfection he attained, but it certainly must have been considerable. Critics may possibly find fault with a few details recorded in his papers, in the volumes of the *Phil. Trans.*, such as the supposed discovery of the ring around Uranus, but when we consider the enormous amount of work he accomplished, sometimes in indifferent air, or amid trying circumstances, he must have been more than mortal could he have invariably avoided mistakes.

Herschel's papers number sixty-nine, and they are practically inaccessible to the general astronomical public, in the volumes of the *Phil. Trans.* Will these important memoirs ever be reprinted in book form?

Every year brings us some new astronomical works, but they are neither so welcome nor so valuable as a volume of Herschel's writings would prove. And this has been a desideratum for more than a century! Had Herschel's collected papers been available for convenient reference what immense trouble would have been avoided, and how many misunderstandings prevented! Some descendant of the illustrious astronomer should present the scientific world with a handy volume of his results described in his own language.

SOLAR DISTURBANCES DURING APRIL, 1911.

By FRANK C. DENNETT.

THERE has been a continuance of the somewhat increased activity upon the solar disc. On three days, April 18th, 19th and 20th, no disturbance, bright or dark was visible; and upon the 16th and 17th only bright, or faculic disturbances were seen. At noon on April 1st the longitude of the central meridian was 188° 56′.

No. 12 on the March list continued upon the disc until April 6th, and therefore re-appears upon the present chart.

No 13.—Near the eastern limb, on the 1st, there appeared a moderate spot, but when farther on the disc it was seen to consist of three spotlets and three pores in slightly divergent lines. The middle, largest spot had the inner edge of its penumbra fringed brightly. The members decreased from the 6th until the 8th when only penumbraless pores were visible having a faculic lip. The length of the group was 44,000 miles. The region was faculic until the limb was reached.

No. 14.—A spotlet, only seen upon the 2nd.

No. 15.—A pore, only visible upon the 4th, approximately in the position shown.

No. 16.—A solitary spot, 10,000 miles in diameter, crossed the disc between the 3rd and 15th. The inner edge of its penumbra was fringed bright upon the 8th, 10th and 12th, whilst the umbra was crossed by a bridge upon 12th and 13th.

No. 17.—A spot, 14,000 miles in diameter, visible from April 22nd until May 3rd. The penumbra brightened inwards upon the 24th, 26th, 27th, 30th, and May 1st, and the umbra was crossed by a bridge on the 24th, and from the 27th until the 30th. On the 28th and 29th the southern half of the umbra appeared to be less dark than the northern.

No. 17*a*.—A fine spot 15,000 miles across, visible from April 22nd until May 5th. The brightening inwards of the penumbra was noted on the same days as No. 17, and also on the 26th. The umbra was crossed by a bridge which became very narrow. A faculic chain, convex northward, joined Nos. 17 and 17a, in which evanescent pores appeared on the 28th and 29th.

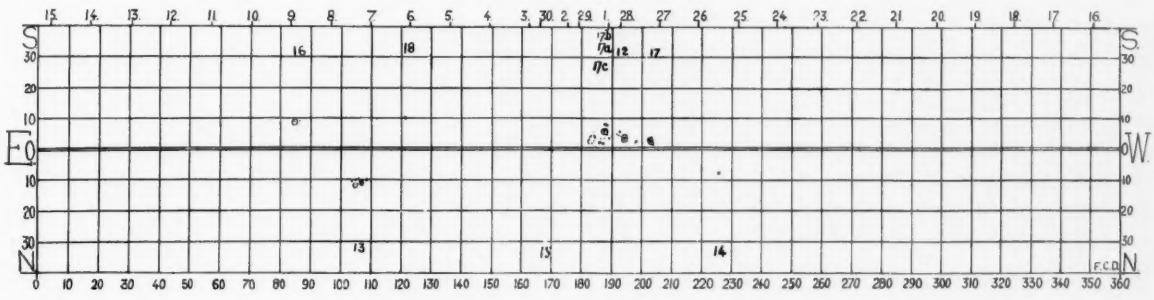
No. 17*b*.—A spotlet seen from the 22nd until May 2nd. There was a bright inner fringe to the penumbra on the 24th. On the 27th the umbra became elongated and on the 28th and 29th broken. Pores showed round it on the 27th, 28th, 29th, and on May 1st.

No. 17*c*.—Two spotlets upon the 24th, one remaining until the 26th.

No 18.—A small group of pores only seen upon the 30th.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett.

DAY OF APRIL.



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NOTICES.

LEWIS'S CIRCULATING SCIENTIFIC LIBRARY.—We have received from Mr. H. K. Lewis, of Gower Street, London, a supplementary catalogue, covering works added to the library during the years 1908 and 1909. The catalogue is published at sixpence, and contains a classified index of subjects with the authors who have written upon them, as well as an alphabetical list of titles. We have on previous occasions called the attention of our readers to the completeness of this library, and the inducements it offers to students of science.

Demonstration Room at the Westminster Electric Supply Corporation.

Mr. Lewis has asked us to mention that his premises will in future be closed at 6.30 p.m., instead of 7 p.m., during the months of June, July and August.

A NEW DISCOVERY.—Smoked glasses, it has been shown, only cut off a part of the ultra-violet rays, which are those which have an irritating effect on the eyes of many people; they also are harmful as they make the retina more and more sensitive to light. A new glass which has been called "Spectros" has been introduced by Messrs. W. Watson & Sons, of High Holborn, which cuts off the ultra-violet rays and yet allows all the remainder to pass freely. It has a pale green tint but it is the chemical constituents upon which its peculiar properties depend, and eye-glasses made from it have not the disfiguring effect of the ordinary smoked ones.

ILLUMINATION.—A very interesting exhibition is now open at the offices of the Westminster Electric Supply Corporation, Limited, in Ecclestone Place, Belgravia. One part of it deals with various systems of electric lighting and the effects which can be produced by them in rooms, while the other shows how electricity can be pressed into domestic service.

Our illustration shows one of the demonstration rooms. Beginning on the extreme left we find that the first ceiling light illustrates the method of downward reflecting by means of an opaque reflector. The second shows one in which there is a white silk shade beneath the lamp to diffuse the light below and produce upward reflection. The fourth, with the bell-shaped shade, illustrates a method of concentrating all the light and reflecting it downwards. The fifth shows upward reflection and slight downward diffusion by means of an opal shade. The seventh gives diffused light by means of holophane glass. The effects of lighting by means of metal filament lamps hidden behind the cornice are also well seen. The candle lamps are used for reflecting from the walls, and the brackets below them are intended for downward lighting.

On the other side of the exhibition we have an elaborate display of the apparatus which is being perfected in connection with cooking by electricity, and an experienced cook is in charge to demonstrate its use. Amongst the exhibits are ranges, ovens, grills, breakfast cookers, kettles and apparatus for giving continuous hot water supply at very small cost. There are also methods of introducing warm fresh air, for keeping towel rails sufficiently hot to air the towels, and motors for working sewing machines and floor polishers as well as soldering irons, hair driers, and curling tongs which are themselves heated by the current as they are used.

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